P Med J

Journal of Bone & Joint Surgery

The Journal of Orthopædic Surgery

The Official Publication of the
American Orthopedic Association
and of the
British Orthopaedic Association

LIBRARY

Volume I

1919

505102
7. 3. 50

EDITED AND PUBLISHED FOR THE AMERICAN ORTHOPAEDIC ASSOCIATION BY

H. WINNETT ORR, M. D., Lincoln, Nebraska

RD
701
J6
n.s
v.1
cop.2

Journal of Orthopaedic Surgery, Volume I, 1919
Author's Index—Original Articles

Bennett, G. E. The Lengthening of the Quadriceps Tendon. Preliminary Report 530

Brackett, E. G. Productive Occupational Therapy in the Treatment of Disability of the Extremities 40

Bradford, E. H. Ambulatory Treatment of Fracture of the Neck of the Femur 465

Case Recording in Spinal Curvature 429

Campbell, W. C. Transference of the Fibula as an Adjunct to Free Bone Graft in Tibial Deficiency 625

Chutro, P. Infected Wounds of the Ankle 521

Cone, S. M. Some Practical Applications of Pathology in the War Injuries of Nerves 157

Cotton, F. J. Reconstruction Hospital on Parker Hill 255

Cowan, J. F., and Ely, L. W. A Study of Buried Bone 100

Danforth, M. S. The Diagnosis and Pre-Operative Treatment of Nerve Injuries 562

Donnelly, L. C. Results Obtained by Treating Weak-Feet Along Military Lines Among Civilians 219

Dunn, N. Calcaneo Cavis and Its Treatment 711

Eickenbary, C. F. The Treatment of Chronic Osteomyelitis 115

Elmslie, R. C. The Relationship of Fracture of the Lower Epiphysis of the Tibia to the Arrest of the Growth of Bone 215

Pseudocoxalgia Following Traumatic Dislocation of the Hip in a Boy Aged Four Years 109

Ely, L. W., and Cowan, J. F. A Study of Buried Bone 100

Evans, E. L. Clonic Spasmodic Contractions, Illustrated by a Case of Clonic Spasmodic Contraction of the Muscles Around the Hip Joint 294

Freiberg, A. H. The Bristow Coil and Treatment by Graduated Muscle Contraction 148

Gallie, W. E. Chronic Septic Inflammation in Bone Following Gun-shot Wound 470

Galloway, H. P. H. President's Address: Readjustment to Changing Conditions 395

Geist, E. S. Non-Union Following the Corrective Osteotomy of the Tibia 527

Girdlestone, G. R. A Note on Pott's Disease and Albee's Spinal Graft 401

Hammond, T. E. Non-Operative Treatment of Nerve Lesions Involving the Upper Extremity 320

Harding, M. C. Severe Acute Sprains of the Knee-Joint 152

Hass, S. L. The Changes Produced in Growing Bone After Injury to the Epiphyseal Cartilage Plate 67, 166, 266

Hess, H. L. Metacarpal and Phalangeal Traction Splint 302

Hodge, R. L. A Simple Splint for the Treatment of Fracture of the Clavicle 439

Jones, A. R. Tendon Fixation in Musculo Spiral Paralysis 135

Kidner, F. C. The Treatment of Ununited Fractures 549

Kilmer, T. W. Mensugraph. A Method of Measuring and Plotting Orthopaedic Deformities by Photography 297
Kleinberg, S. Tuberculin 722
Langworthy, M. The Treatment of Joints Stiffened by War Injuries 349
Lewis, F. E. A Splint Devised for the Treatment of Stiff Metacarpo Phalangeal Joints 222
Little, E. M. Two Unusual Complications in Amputation Stumps 457
Specialism and General Surgery. Presidential Address. British Orthopaedic Association 63
McMurray, T. P. Discussion of the Indications, Technique and Results of Transplantation in Gunshot Injuries of Nerves 125
Mayer, Leo. Infected Gunshot Injuries of the Hip 7
Merrill, W. J. Mesial Triprism 434
The Pedal Groups 562
Tarsal Torsion in Weight Bearing 23
Mumford, E. B. The Application of Curative Therapy in the Workshop 676
Metcalf, C. R. Impairment of Function of the Hand Due to War Injuries 198
Nutter, J. A. The Standardization of Joint Records 423
Ogilvy, C. Operation for Permanent Correction of Weak Feet in Children 343
Osgood, R. B. Gunshot Injuries to Joints 304
The Orthopaedic Outlook 1
A Survey of the Orthopaedic Services in U. S. A. General, Base and Debarkation Hospitals 359
Painter, C. F. Fracture Dislocation of Head of Right Humerus, An Unusual Case 468
Internal Derangements of the Knee-Joint 416
Platt, Harry. Treatment of Flail Joints of the Upper Limb Following Gunshot Injuries 667
Roberts, P. W. Osteochondritis of the Hip 493
Sever, J. W. Disability Following Injuries to the Back in Industrial Accidents 657, 743
Steindler, A. Operative Treatment of Paralytic Conditions of the Upper Extremity 608
Tendon Transplantation of the Foot, Report of 48 Cases 187
Stern, W. G. A Report on the Cleveland and Elyria Cripple Surveys 23
Swaim, L. T. Some Interesting Back Cases 249
Swett, P. P. Personal Experience in the Use of Lane Plates 673
Truslow, W. A Self-Correcting Brace for Lateral Curvature of the Spine 547
Verrall, P. J. Stiff Fingers: With Special Reference to Methods of Treatment by Metal and Plaster Splints 335
Wallace, J. O. Diagnosis of Syphilis of Bones and Joints 258
Whitman, R. Loop Operation for Paralytic Deformities of the Foot 459

Journal of Orthopaedic Surgery, Volume I, 1919

*Subject Index

Abduction Method of Treating Fracture of the Neck of the Femur. A Demonstration.—Whitman, R. 393
Abduction Treatment of Fracture of the Neck of the Femur,—*Whitman, R.* *248*
Ambulatory Treatment Fracture of Neck of the Femur,—*Bradford, E. H.*... *465*
American Expeditionary Forces and Medical Work,—*Osgood, R. B.*..... *52*
American Journal of Orthopedic Surgery..... 682
American Orthopedic Association Meeting.....180, 242, 387
Amputation of the Leg, New Procedure in,—Phocas..... 243
Amputation, Open, Through Knee-Joint,—Smith, M. K..... 702
Amputation, Spurlike Formation of Bone Following,—Morgan, J. D..... 390
Amputation Stumps, Complications of;—*Little, E. M.*..... *457*
Amputations,—Chisholm 636
Amputations, Cinematic,—Gunn and Gallie..... 637
Amputations of the Foot,—Corlette..... 647
Ankle, Infected Wounds of,—*Chutro, P.*..... *521*
Ankle, An Operation for Stabilizing the Foot and,—in Poliomyelitis,—Peckham, F. E. 61
Ankle-Joint, Fractures of,—Stoner, A. P..... 694
Apparatus, Immediate Application of, In Cases of Amputations of Lower Limbs,—Roederer 244
Appliances, Orthopaedic, Use of, in the Treatment of War Disabilities,—LeMesurier 763
Arm, Paralysis of the, Operations for,—*Steindler, A.*..... *608*
Arthritis, Deforming, of the Hip—Beaujard, Roussy, Caillods and Cornil..... 451
Arthritis of the Hip-Joint, Tuberculous Diagnosis and Treatment of,—Meyerding 124
Arthritis, Purulent, Treatment of,—Willems..... 504
Arthritis, Suppurative Treatment,—Everidge..... 583
Arthritis, Teeth and Tonsils as Factors in,—Hammond, R..... 57
Arthritis, Tonsillectomy in,—Little and Ryons..... 452
Arthroplasty,—Baer, W. S..... 652
Arthrotomy, Treatment by Wide,—Willems..... 504
Articulorum, Hydrops, Two Cases of Intermittent,—MacClelland, H..... 453

Back-Ache, Common Lesions Producing,—Shackleton, W. F..... 183
Back Cases, Some Interesting,—*Swain, L. T.*..... *249*
Back Injuries,—*Sever, J. W.*.....657, *743*
Back Injuries,—Wallace 633
Bibliography—
Current Orthopaedic Literature.....685, 755
Bone Affections, Radiographic Differential Diagnosis of,—Hess, J. H..... 770
Bone, Buried, A Study of,—*Cowan and Ely*..... *100*
Bone Cavities, The Closure of,—Sargent, P..... 446
Bone Changes, After Injury to Epiphyseal Cartilage Plate,—*Haas S. L.* *67, 166, 266*
Bone, Disease of,—DeGanlejac and Nathan..... 510
Bone Graft and Arthritis. Reconstruction Surgery. Dubose..... 51
Bone Graft for Femur Defects,—Davison..... 644
Bone Graft, Part Played By,—Mamourian, M..... 49
Bone Grafting, Spinal,—Lambert, T. E..... 51

*Articles published originally in this Journal indicated by capitals.

Bone Grafts,—Keith 653
Bone Grafts, Segmentary, in Military Surgery,—Mauclaire 447
Bone, Gunshot Wounds of,—DeGaulejac 507
Bone Regeneration in Bone Graft,—Dupuy DeFrenelle 642
Bone Regeneration in Osteomyelitis,—McCurdy 643
Bone, Sepsis of,—*Gallie W. E.* *470*
Bone, Spur-Like Formation of, Following Amputation,—Morgan, J. D. 390
Bone Transplant from the Tibia to the Lower Jaw,—Powers, C. A. 772
Bone and Joint Lesions of Yaws,—Maul, H. G. 709
Bones, Long, Pseudarthroses of,—Glueke 697
Bones and Joints, Syphilis of. Diagnosis,—Wallace, J. C. 258
Book Reviews—
Fractures, Treatment of, by Suspension,—P. DesFosses and Charles Robert 240
Functional Prosthesis of the War Wounded,—Ducroquet 443
Gunshot Fractures of the Extremities,—Blake 386
Prosthesis of the Lower Limbs,—Martin, F. 383
Skeleton, The Human,—Walter, H. E. 47
Treatise on Orthopedic Surgery,—Whitman, R. 444
Treatment of War Wounds by Method of Menciere—Creignon 315
Bowlegs, Non-Union After Operation for,—*Geist, E. S.* *527*
Brace, Self-Correcting for Lateral Curvature of the Spine,—*Truslow, W.* *547*
Bristow Coil and Treatment by Muscle Contraction,—*Freiberg, A. H.* *148*
British Orthopaedic Association Meeting, Annual 442, 499, 632

Calcaneo Cavus and Its Treatment,—*Dunn, N.* *711*
Casualties of War and Industry and Their Relationship to Orthopedic Surgery,—Freiberg, A. H. 49
Clavicle, Fracture of, Barrel-Stave Splint in,—Royster, H. S. 769
Clavicle, Fractures of, A Simple Splint for the Treatment of,—Hodge, R. L. 439
Cleveland, Ohio, Survey of Cripples in,—McMurtrie 649
Cleveland and Elyria Cripple Surveys, A Report on,—Stern, W. G. 23
Contracture, Dupuytren's,—Gill, A. B. 696
Contracture, Volkmann's Pathological Treatment of,—Rene Dumas 59
Contractures, Clonic Spasmodic,—Evans, E. L. 294
Contractures, Hysterical,—Hurst 500
Contractures, War, Localized Tetanus, Etc.—Hurst 500
Correspondence—
Manuscripts of Medical Officers of the U. S. Army, Regulations for 254
Traction, Stretching, Suspension 47
Cripple Surveys of Cleveland and Elyria, A Report on,—Stern, W. G. 23
Crippled Children. Their Physical and Educational Needs,—Horwitz, A. E. ... 389
Cripples, Civilian, Editorial 497
Cripples, Survey of,—McMurtrie 649
Crucial Ligaments, Injuries to,—Smith 517
Current Orthopaedic Literature—
..... 49, 119, 181, 243, 316, 389, 446, 500, 573, 633, 691, 760
Curative Therapy in the Work Shop, Application of,—*Mumford, E. B.* *676*
Disability Prevention and Time Saving, Following Industrial Accidents,—Editorial 752
Disabled Soldiers, Independence for,—McMurtrie 646
Dislocation of Hip, Congenital,—Jahss 57

Editorials—
Care of Civilian Cripples 497
Journal of Orthopaedic Surgery, History of 46
Notes on the History of Orthopaedic Surgery 683
Time Saving and Disability Prevention Following Industrial Accidents 752
Education, Vocational, Federal Board for,—Brunson 645
Educational Needs of Crippled Children,—Horwitz, A. E. 389

Epiphysis, A Study of the Development of the,—Kruescher, P. H. 182
Epiphyseal Cartilage Plate, Bone Changes After Injury to the,—*Haas, S. L.* 67, 166, 266
Equino Valgus, Paralytic, Operation for,—*Whitman* 459
Extremities, Bone Surgery of,—Thompson 586
Extremities, Conditions Found in,—DeGaulejac and Nathan 510
Extremities, Disabilities of, Productive Occupational Therapy in the Treatment of,—*Brackett, E. G.* 40
Extremities, Upper, Operative Treatment of Paralytic Conditions of,—*Steindler, A.* 608
Extremities, Upper Non-Operative Treatment of Nerve Lesions Involving the,—*Hammond, T. E.* 320

Fat Embolism,—Caldwell and Huber 655
Femur, Central Dislocation of (Intra-Pelvic Displacement) 760
Femur, Defects of, Bone Graft for,—Davison 644
Femur, Fracture, Gunshot,—Buchbinder 589
Femur, Fracture of the Neck of the, Abduction Treatment of,—Whitman, R. 248
Femur, Fracture of the Neck: Treatment by Abduction Method, A Demonstration,—Whitman, R. 392
Femur, Fractures of,—Hardouin 507
Femur, Fractures of,—Hurley and Weedon 508
Femur, Fractures of,—Massie 511
Femur, Fractures of,—Van de Velde 767
Femur, Fractures of, Neck of the,—*Bradford, E. H.* 465
Femur, Luxation of,—Froelich 511
Feet, Flat, Treatment of,—Burk 520
Feet, Flat and Weak,—Scheimberg, H. 392
Feet, Static Defects of the,—Rich, E. A. 186
Fibula, Transference of, for Tibial Defect,—*Campbell, W. C.* 625
Fingers, Injuries to,—Hughes, W. K. 389
Fingers, Stiff, With Special Reference to Methods of Treatment by Metal and Plaster Splints,—*Verrall* 335
Flail Joints After Resection, Treatment of,—Tavernier and Jalifer 592
Flail Joints of the Upper Limb, Following Gunshot Injuries, Treatment of,—*Platt, H.* 667
Fluid, Synovial, An Artificial,—Morris, R. T. 389
Focal Infection as a Cause of Painful Heel,—Epstein 641
Foot, Amputations of,—Corlette 647
Foot, Disabilities, Mild and the Army Shoe,—Rugh 56
Foot, Flat,—Crandon 520
Foot, Flat, Treatment of,—Burk 520
Foot Muscles (The Pedal Groups)—*Merrill, W. J.* 562
Foot, Problem, The,—Mebane, T. S. 56
Foot and Ankle, An Operation for Stabilizing,—Peckham 61
Fracture, Clavicle, Barrel-Stave Splint, in,—Royster 769
Fracture, Cervical Vertebra, With Restoration of Bony Substance,—Luckie, L. F. 394
Fracture, Femur,—Bulkley, S. 575
Fracture, Femur, Gunshot,—Buchbinder 589
Fracture, Femur, Neck of,—*Sever, J. W.* 247
Fracture, Femur, Neck of, Abduction Treatment,—Whitman 248
Fracture, Femur, Neck of, Treatment of by the Abduction Method, A Demonstration,—Whitman, R. 392
Fractures, Clavicle, A Simple Splint for the Treatment of,—*Hodge, R. L.* 439
Fractures, Complicating the Ankle-Joint,—Stoner 694
Fractures, Compound,—Slessinger 509
Fractures, Compound, Treatment of, by the Use of the Triangle Splint,—Turner, P. 394
Fractures, Femur, Lower Third,—Van de Velde 767

Fractures, Gunshot,—Wilson 691
Fractures, Humerus, Gunshot,—Smith, M. K..... 769
Fractures, "No-Splint" Treatment of,—Dowden 507
Fractures, Overlapping, Application of Extension to,—Freeman..... 696
Fractures, Patellar Border, Recognition and Significance of,—Salmond..... 456
Fractures, About Shoulder, In Humerus and About Elbow,—Dowden, J. W... 394
Fractures, Spinal Column With and Without Cord Injury,—Sharpe, N..... 61
Fractures, Sub-Trochanteric, Reduction of, by Ventral Position,—Constantini and Vigot 456
Fractures, Treatment of, by Suspension and Traction,—Moore, G. A..... 54
Fractures, Ununited,—Brackett, E. G..... 654
Fractures, Ununited, of the Patellar and of the Olecranum,—Albee, F. H..... 455
Fractures, Ununited, Treatment of,—*Kidner, F. C.*..... *549*

Hallux Valgus, A New Operation for,—Rugh, J. T..... 245
Hallux Valgus, Surgical Treatment of,—Field, J..... 699
Hand, Impairment of Function of, Due to War Injuries,—*Metcalf, C. R.*..... *198*
Hand, Problems of Reconstruction,—Steindler..... 55
Hand and Forearm, Orthopaedic Reconstruction Work on,—Steindler, A..... 244
Hands and Feet, Practical Method for Making Molds of,—Roederer..... 317
Heel, Painful, Focal Infection as a Cause of,—Epstein..... 641
Hemiplegia, Orthopaedic Treatment of,—Taylor, A. S..... 708
Hemophilia, Case of, With Effusion Into the Knee-Joints,—Roth, P. B..... 59
Hip, Arthritis of the, Deforming, in the Adult,—Beaujard, Roussy, Caillods, and Cornil 451
Hip, Congenital Dislocation of,—Jahss, S. A..... 57
Hip, Congenital Dislocation of, Use of Continued Extension by Means of a New Extension Frame in the Bloodless Reduction of,—Churchman, J. W. 450
Hip, Gunshot Wounds of,—Mayer, L..... 590
Hip, Infected Gunshot Injuries of the,—*Mayer, L.*..... 7
Hip, Osteochondritis of the,—*Roberts, P. W.*..... *493*
Hip, Traumatic Dislocation of, Pseudocoxalgia Following,—*Elmslie, R. C.* *109*
Hip Joint, Diagnosis and Treatment of Tuberculous Arthritis of the,—Meyerding, H. W. 124
Hip-Joint, Tuberculosis of the,—Gauvain, H. J..... 183
Historical Note on Orthopaedic Surgery—Editorial..... 683
Hodgen, Wire Cradle Extension Suspension Splints,—Nifong..... 50
Humerus, Fracture, Dislocation,—Painter, C. F..... 468
Humerus, Fractures of, Treatment by Suspension and Traction,—Smith, M. K. 769
Humerus, Fractures of Upper End,—Stevens..... 512
Humerus, Pseudarthroses of,—Dujarier, C..... 692

Joint, Flail, Treatment of,—*Platt, H.*..... *667*
Joint, Records, Standardization of,—*Nutter, J. A.*..... *423*
Joint, Resection, Flail Joint,—Tavernier and Jalifer..... 592
Joint Wounds (and Bone), Some Points in the Treatment of,—Teece, L. G. 53
Joints, Gunshot Injuries to,—Osgood, R. B..... 304
Joints, Gunshot Wounds, Infections,—Mollenhauer and Mayer..... 590
Joints, Laceration and Infection of, in Children,—Mitchell..... 184
Joints, (Stiff) Metacarpo Phalangeal, Splint Devised for Treating,—*Lewis, F. E.*..... *222*
Joints, Primary Suture of,—LeFur, R..... 709
Joints, Stiffened by War Injuries, Treatment of,—*Langworthy*..... *349*
Journal of Orthopaedic Surgery, Editorial..... 46

Knee-Joint, Arthritis of, With Suppurative Treatment,—Everidge..... 583
Knee-Joint, Case of Loose Bodies in,—Roth, P. B..... 185
Knee-Joint, Derangements of Semi-Lunar Cartilage of,—Henderson, M. S..... 453

Knee-Joint, Injury of,—Smith 524
Knee-Joint, Mechanical Derangements of—Henderson, M. S. 391
Knee-Joint, Open Amputation Through the Knee-Joint—Smith 702
Knee-Joint, Sprains, Severe Acute,—Harding, M. C. 152
Knee-Joint, War Injuries, Willems' Treatment,—McWilliams and Hetzel 704
Knee-Joint Wounds, Treatment of,—Pool and Jopson 702
Knee-Joints, Case of Hemophilia, with Effusion Into the,—Roth, P. B. 59
Knee-Joints, Internal Derangements of,—*Painter, C. F.* *416*
Kobler's Disease,—O'Brien 508

Lane Plates, Use of, Personal Experience in the,—*Swett, P. P.* *673*
Leg, Amputation of, New Procedure in,—Phocas 243
Leg, Bone Surgery of,—*Campbell, W. C.* *625*
Limbs, Functional Disability of,—Morton 516
Limbs, Lower, Amputation of: Immediate Application of Apparatus in Cases of,—Roederer 244
Limbs, Upper,—Slessinger 509
Loop Operation for Paralytic Deformities of the Foot,—*Whitman, R.* *549*
Lumbosacral Region, Pain in,—Richards, A. J. 768
Luxations and Dislocations, Congenital,—Jahss, S. A. 57

Mechano-Therapy,—Scal 642
Mechano-Therapy, Some Errors and Prejudices Concerning,—Sandoz 449
Mensugraph: A Method of Measuring and Plotting Orthopedic Deformities by Photography,—*Kilmer, T. W.* *297*
Mesial Triprism,—*Merrill, W. J.* *434*
Metacarpal and Phalangeal Traction Splint,—*Hess, H. L.* *302*
Mobilization, Active,—Willems 511
Myositis, Ossificans, Progressiva, A Contribution to the Study of,—Rosenstern, J. 318

Nerve Defects, Bridging of,—Stookey, A. M. 695
Nerve Injuries, Diagnosis and Pre-Operative Treatment of,—*Danforth, M. S.* *563*
Nerve Injuries, Peripheral, Investigation of 1,000 Cases of,—Burrow, J. L., Carter, H. S. 245
Nerve Injuries, Peripheral, Mechanical Treatment of.—Stookey, B. 246
Nerve Injuries, Peripheral, Surgical Consideration of,—Stookey, B. 123
Nerve Surgery,—Adson 655
Nerve Suture,—Blencke 514
Nerve Transplantation, Autoplastic, In the Repair of Gunshot Injuries,—Mayer, Leo 181
Nerves, Peripheral,—Blencke 514
Nerves, Transplantation in Gunshot Injuries of, Indications, Technique and Results of,—*McMurray, T. P.* *125*
Nerves, War Injuries of, Some Practical Applications of Pathology in the,—*Cone, S. M.* *157*
Non-Union After Osteotomy,—*Geist* *527*
No-Splint Treatment of Fractures About Shoulder, in Humerus and About Elbow,—Dowden, J. W. 394

Olecranon, Ununited Fracture of,—Albee, F. H. 455
Operation, Position of, in the Excision of Cartilage in Military Surgery,—Hammond, T. E. 316
Operations, Tendon,—Mayer, L. 50
Orthopaedic Appliances, Use of, in the Treatment of War Disabilities,—LeMesurier, A. L. B. 763
Orthopedic Events, Current 684, 753
Orthopedic Literature, Current, Abstracts of—
..... 49, 119, 180, 243, 316, 389, 446, 500, 573, 633, 691, 760
Orthopedic Literature, Current, Bibliography of 685,-755

Orthopaedic Outlook, The,—Osgood, R. B. 1
Orthopaedic Services of the U. S. A. General, Base and Debarkation Hospitals, A Survey of,—*Osgood, R. B.* 359
Orthopaedic Surgery, Historical Note on, Editorial 683
Orthopaedic Surgery, Progress of, Collective Abstract 652
Orthopaedic Surgery, Surgical Technique in,—Elmer, W. H. 243
Orthopaedic Surgery and Casualties of War and Industry,—Freiberg, A. H. 49
Osteitis Deformans. A Report of Two Cases,—Leahy 186
Osteochondritis of the Hip,—*Roberts, P. W.* 493
Osteomyelitis,—Baetjer 573
Osteomyelitis, Bone Regeneration in,—McCurdy 643
Osteomyelitis, Chronic, Treatment of,—*Eickenbary, C. F.* 115
Osteomyelitis, in Children,—Wood, A. C. 390
Osteoplastic Surgery During the War,—Charbonnel 448
Osteotomy, Non-Union After,—*Geist, E. S.* 527

Paralysis of the Arm, Surgery of,—*Steindler, A.* 668
Paralysis, Cerebral Spastic,—Blahd and Stern 185
Paralysis, Grave, in Gunshot Wounds of the Spine, Operative Treatment of,—Neuhof, H. 390
Paralysis, Spastic, in Children,—Grossman, J. 700
Paralytic Genu-Recurvatum, Operation for the Correction and Prevention of,—Campbell, W. C. 60
Patella, Ununited Fracture of,—Albee, F. H. 455
Pedal Groups,—*Merrill, W. J.* 562
Pelvic, Displacement, Intra 760
Pelvic Erruption,—Froelich 518
Personal Mention 684, 752
Perthes Disease,—Watkins, W. W. 453
Philadelphia Orthopaedic Club Meeting 754
Posture, Good,—Rogers, J. F. 392
Pott's Disease, Surgical Treatment of,—McIlhenny, P. A. 390
Pott's Disease and Albee's Spinal Graft, A Note on,—*Girdlestone, G. R.* 401
Prize, Samuel D. Gross 754
Pseudarthroses of the Humerus,—Dujarier, C. 692
Pseudarthroses of the Long Bones,—Glueke 697
Pseudocoxalgia Following Traumatic Dislocation of the Hip,—*Elmslie, R. C.* 109
Public Provision,—McMurtrie 520
Putti Method in Amputations,—Gunn and Gallie 637

Quadriceps Tendon, Lengthening of,—*Bennett, G. E.* 530

Radio-Ulnar Synostosis,—Sever, J. W. 651
Readjustment to Changing Conditions: Presidential Address—*Galloway, H. P. H.* 395
Reconstruction, Disabled Soldier,—Billings 639
Reconstruction Hospital on Parker Hill,—*Cotton, F. J.* 255
Reconstruction, Physical, and Orthopaedic Surgery,—Goldthwait 699
Reconstruction Surgery with Reference to Bone Graft and Arthritis,—F. G. Dubose 51
Reconstructive Surgery. A Problem of Records,—Nutter 245
Rehabilitation of Disabled in Italy,—Putti, V. 701
Retractor, Self-Retaining for Use with Albee Bone Outfit,—Lowman and Pratt 182
Rickets, Cause of, Observation on the,—Paton, Findlay, and Watson 392

Scaphoid, Disease of,—McClure, C. R. 58
Scaphoid, Tarsal,—O'Brien 508
Scapula, Congenital Elevation of the,—Peckham, F. E. 654
Scars, Surgery of,—Walther 656

Shoulder, Fractures of,—Dowden 507
Shoulder, Stiff and Painful,—Brown, A. J. 762
Society Meetings—
American Orthopedic Association 180, 242, 387
British Orthopaedic Association 442, 499, 632
New York Academy of Medicine, Section on Orthopaedic Surgery 180, 315
Philadelphia Orthopaedic Club 754
Soldier, Disabled,—McMurtrie 513
Soldiers, Disabled,—Billings 639
Spinal Bone Grafting,—Lambert, T. E. 51
Spinal Column, Fracture, With and Without Cord Injury,—Sharp, N. 61
Spinal Curvature, Case Recording in,—*Bradford, E. H.* 429
Spin, Cervical Injuries of,—Ransohoff, J. 246
Spine, Curvature of,—Bradford, E. H. 587
Spine, Curvature of, Brace for,—*Truslow, W.* 547
Spine, Operative Treatment of Gunshot Wounds of, With Grave Paralysis,—Neuhof, H. 390
Spine, Typhoid,—Osler, Sir Wm. 184
Splint Devised for Treatment of Metacarpo-phalangeal Joints,—Lewis 222
Splint, Triangle, Use of, in the Treatment of Compound Fractures of the Humerus,—Turner, P. 394
Splints, Metal and Plaster, in the Treatment of Stiff Fingers,—Verrall, P. J. 335
Splints, Transport of the American Army,—Osgood, R. B. 50
Splints, for Transportation,—Emerson, K. 52
Spondylitis, Post-Traumatic,—Cluzet 454
Surgery, Front, Growth of,—Bowlby, Sir A. 693
Surgery, Front Hospitals,—Pool, Lee and Dineen 122
Surgery, General, Specialism and,—*Little, E. M.* 63
Surgery, Influence of the War Upon,—Blake 576
Surgical Anatomy, Bones of Extremities,—Thompson 586
Suspension and Traction Treatment of Fractures,—Moore, G. A. 54
Synostosis, Radio-Ulnar, Congenital,—Sever, J. W. 651
Synostosis, Radio-Ulnar, Congenital, Case of,—Kopelowitz 391
Synovial Fluid, Artificial,—Morris, R. T. 389

Tarsal Torsion in Weight Bearing,—*Merrill, W. J.* 83
Tendon Fixation in Musculo Spiral Paralysis,—*Jones, A. R.* 135
Tendon Transference Technique,—Bernstein 591
Tendon Transplantation of the Foot,—*Steindler, A.* 187
Tendons, Anatomy and Physiology of,—Mayer, Leo 50
Tetanus, Localized,—Hurst 500
Thomas Splint, Modified,—Hardouin 507
Thumb, New Operation for Substitution of the,—Joyce, J. L. 181
Thumb, Plasty, Late Results of,—Shepelmann, E. 760
Tibia, Bone Transplant from, to the Lower Jaw,—Powers, C. A. 772
Tibia, Lower Epiphysis of, Relationship of Fracture of, to the Arrest of Growth of Bone,—Elmslie, R. C. 215
Time Saving and Disability Prevention Following Industrial Accidents, Editorial 752
Tonsillectomy in Myositis and Arthritis,—Little and Ryons 452
Tributes—
Davis, Gwilym G.,—Rugh, J. T. 570
Wilson, H. Augustus,—Lovett, R. W. 569
Tuberculin, Its Use in Treatment of Tubercular Bones and Joints,—*Kleinberg, S.* 722
Tuberculosis of the Hip-Joint,—Gauvain 183
Tuberculosis, Vertebral, Treatment of, by Fusion Operation,—Hibbs, R. A. 57

Vertebra, Cervical, Fracture of, With Restoration of Bony Substance,—Luckie, L. F. 394
Vertebra, Fifth Lambar, Associated with Lumbosacral Pain,—Richards 768
Vocational Education, Federal Board for,—Brunson 645

Weak Feet in Children, Operation for Permanent Correction of,—*Ogilvy, C.* *343*
Weak Feet, Results Obtained by Treating, Along Military Lines,—*Donnelly, L. C.* *219*
Workshop, Curative Therapy, Application in,—*Mumford, E. B.* *676*
Wounds, Infected,—*Chutro, P.* *521*
Wrist, War Surgery of,—Combier and Murard 119

Vol. I, No. 1 JANUARY, 1919 Old Series: Vol. xvii, No. 1

The Journal of Orthopædic Surgery

THE ORTHOPÆDIC OUTLOOK.

BY ROBERT B. OSGOOD, LIEUT.-COL., M.C.

To obtain a physical outlook we must seek some "Peak in Darien." If we are in the woods we must ascertain in some way whether we may pass beyond the woods by proceeding in a certain direction or whether those woods stretch too far for us to be able to escape with our present store of strength.

If they are too extensive we may be obliged to cut down trees and make a clearing and work out our own salavation as pioneers. We must eventually build roads to the settlements and establish contact relations. The continuance of these contacts must be based on reciprocal demands. To obtain a mental outlook is more difficult. The only picture which can be free from distortion is that composite which is derived from the mirror of our own honest estimation, and the image of ourselves as others see us.

The physical outlook varies with our position; the mental outlook, with our attitude. What is our position at present with the other branches of the medical profession and what is our attitude toward them?

If we can properly discover our position and determine what our attitude is and is to be, we may venture to prophesy, and this prophecy is the outlook as it appears to us.

What is our position at present with relation to the other branches of the medical profession?

Are we in contact with them or are we really isolated? In many places we are in closest contact and the rates of exchange are fair. In

other regions, far too numerous, we represent still more or less isolated groups, sometimes finding existence in the woods precarious, and unable to build roads to the settlements.

We have been a small specialty. Our early masters were pioneers and it was long before their contacts were established. The profession of medicine is still a mystery and an art. It would be well if the mystery were cleared, but we shall not see the art made science in our day. In the early days, and in what we may, at present, call pioneer medical communities, orthopædic surgeons were, and are, looked upon with askance. There is a reason for this and, to some extent, a just reason. It is because an artist abhors a mechanician. The early ortho pædic surgeons were brace makers and we, their descendants, are brace makers still.

A man may be respected if he is a surgeon first and a brace maker afterwards, if he is a surgeon by ability and intent and a brace maker by necessity. He will not be respected if he is a brace maker first and a surgeon afterwards, nor will he be respected if he is a surgeon only by necessity. From the barber surgeon developed the Royal College, but not because they became better barbers as the years went on.

We are quite clear in our own mind concerning the soundness of the underlying orthopædic principle. We like to derive the polyglot work from ὀρθός and παιδεύω, to educate straight. A specialty of function and not of anatomy. Perhaps it is too broad, too inclusive. Does not all medicine and surgery attempt to make straight? What right has a small body of men to claim it as their special task? The only right is because few general surgeons and few internists have considered it their task. The derelict no one wanted.

When the wound made by nature or by art was healed, too often the task has been considered done. The foot fixed in equino valgus after a Pott's fracture, the flexed knees of an arthritis whose fire has long died out, these are bad surgical and medical results which have excused the existence of the orthopædic surgeon and given him his daily bread.

Of late years they have helped to give him his hospital and teaching positions also, for while tuberculosis and poliomyelitis and rickets and the other chronic bone and joint diseases are still his dole, the lay public are discovering what the rank and file of the medical profession have failed to appreciate, that lesions of the joint mechanism of the body, bones, muscles, nerves must be treated by physiological quite as much as by anatomical methods and that the end result must

be judged by the amount of useful function and not by the beauty of the scar.

This conception which was gradually taking shape, has become much more definite since 1914. Cases began to stream back from the war to home hospitals in France and England whose wounds were healed, whose fractures were united, whose joint sepsis was over, but whose contracted muscles and badly aligned bones and joint deformities represented crippling problems demanding longer and more special treatment than the original lesions.

These were deformities which could be accounted for, which could be excused, for which no one surgeon was to blame, but they were not essential deformities and half of them might have been prevented.

The stream continues to flow, though the preventable deformities are lessening and we believe this is because a more perfect radial control is being worked out in our own army and in the armies of our allies, which control jealously guards function and directs treatment for its conservation from the trenches to the home hospitals.

And, now, having tried to honestly estimate ourselves, let us criticise ourselves as severely as we can. It is true that many orthopædic surgeons have the respect and confidence of many general surgeons, but the specialty as a whole, has not. There must be a reason for this, for the attitude of the general surgeon cannot be engendered by jealousy, the specialty has been too small for that, and the general surgeons are, as a class, too fair. The lack of confidence has been caused by the general impression which exists in the profession that orthopædic surgeons are surgeons only in name. The feeling approaches a benign contempt. As long as we stay as a class, basically mechanicians, we shall deserve this contempt and not deserve its benignity.

It is probably true that no living surgeon combines in his technique such perfect asepsis and such absence of faddism, such manual dexterity and such anatomical knowledge, such power of diagnosis and such ability to obtain functionally good end-results as Sir Robert Jones. We claim him as an orthopædic surgeon. He wishes to be so claimed, but as yet he is only the ideal and not the type. He was a general surgeon of wide practice and unusual success long before he determined to devote his life to the functional surgery of the extremities and the spine. He is an orthopædic surgeon not because he cannot be a general surgeon, but because the cripple appeals to his great heart as it did to his uncle, Hugh Owen Thomas, before him.

Most orthopædic surgeons can cut the tendo Achillis successfully.

A smaller number can remove a torn semilunar cartilage without danger of infection and without damage to the function of the knee joint: but few can do well either a difficult bone graft or excise a hip joint.

The complicated fresh joint fracture, especially if it be compound, is usually safer still as an emergency in the hands of the eminent general surgeon than the eminent orthopædic surgeon. Later, after the acute surgery is done, the orthopædic surgeon may be more surely trusted to think of the end result in terms of function, and this is the consideration which chiefly concerns the patient; but ought we to be obliged to divide authority?

There is no excuse for the failure to acquire good surgical technique if any surgery whatever is to be done. An orthopædic surgeon may say he does not believe in too much operating, meaning thereby that he thinks too much operating is being done. This does not excuse him Difficult as it may be for this man to keep his "hand in," he had much better keep both his hands out and turn his operative work to another.

Surgical judgment is a real thing. It is born in few men and is usually acquired only by experience. Unless new lines of endeavor are drawn and new avenues of opportunity are opened, this judgment must be gained by experience in general surgery before orthopædic surgery is adopted as a specialty.

We have far too small a proportion of operating surgeons whose judgment is good, whose anatomical knowledge is accurate, and whose aseptic technique is faultless.

We must have a larger proportion if we are to talk about conserving function and have our peers as well as our patients listen.

And now what is the orthopædic outlook?

We believe we have something to give, and we believe that general surgeons have something to take. We must progress beyond the ultimate wish of the German surgeon, "I pray that they do not die on my hands," and cherishing the dictum of Ambrose Paré that the first duty of the surgeon is to do no harm, we must contend that his last duty is to give back to the patient his fullest degree of function.

This emphasis on function is peculiarly a contribution of the orthopædic surgeon and a contribution which should be accepted by the general surgeon.

The war has suddenly brought into prominence a small specialty. It is fair to say that many honest surgeons believe into too great prominence. Will it remain a specialty? Probably yes. We believe that

the final judgment will be that the specialty has rendered a great service to the soldier and to the nation by insisting that locomotive, wage-earning function, conserved and increased, is the chief end of life-saving surgery. It has maintained that a small group of surgeons were specially fitted to direct this conservation and repair. We believe it was right to do so. It was not being done without them; it is being done with them.

It may very well be that old boundary lines will change as they have changed in Europe. It may well be that kindred aims will draw together groups who have been so widely separated as certain peoples now forming nations. Those who have lived together geographically, but not sympathetically, may separate.

And if the dominant air of the specialty was too shrill at first and harsh to many ears, it may yet be merged into a theme and add a motif to a symphony.

The French have found the need of it, and have trained special men for it, but they have not called it orthopædic surgery. The Italians and English have demanded it and used the old name, but a new Italian journal appears, called the Journal of Surgery, having to do with the function of the structures of the extremities, and Sir Robert Jones has accepted the term of Special Surgical Hospitals in place of the designation of Orthopædic Centres, though the character and control of the work have not changed. They have become still more firmly established and recognized.

The name is nothing, the principle is everything, and the principle has been demonstrated to be valid and enormously important in war surgery.

The war is over and war surgery will finally disappear. Shall we swing back to rest on our braces or can we apply the principle more widely than we have done to the lesions of civil life?

There is a field in which are produced crops of injuries which differ only in degree and not in kind, from war injuries. The principles which should govern the treatment of these lesions are exactly those which have been found necessary for the national welfare in the war wounds of the extremities and spine.

The field is Industrial Surgery. It is recognizing itself along with industrial medicine and the importance of the functional results are being realized by state industrial accident insurance boards. Already one State commission has associated itself with a State medical school. The medical school has taken a hospital which it has staffed with or-

thopædic and general surgeons, who do not lose sight of functional end-results.

Curative workshops are being installed and lessened insurance payments, fewer idle days, decreased doctors' fees, may be as confidently expected from this attack on the potentially crippling injuries of peace as on those of war.

We believe that industrial surgery opens a wide door to orthopædic principle and practice.

The outlook is alluring because the vision of opportunity is clear and wide and varied.

Our contacts, however, must be closer if we are to seize our opportunity. We must still teach human mechanics and even braces. We must teach the conservation of function in chronic bone and joint disease and in paralytic conditions, but we must learn, also, and then help teach how to apply these principles to the traumatic lesions of adults in which chronicity and loss of function are threatened.

We must measure up to surgical standards of general surgeons. Whether we wander into new country and make new friends does not matter. We may even change our designation and run no risk of losing our identity.

In a letter to an eminent general surgeon, Sir Robert Jones has said, "Our desire is to attract them to the work so as to furnish the best possible treatment to soldiers and civilians and to incorporate these principles of treatment into the education of the general surgeon."

We can ask for nothing better for the specialty than the fate of Tennyson's seed.

"Once in a golden hour I cast to earth a seed;
Up there came a flower; the people said a weed.
To and fro they went, through my garden bower,
And murmuring discontent cursed me and my flower.

"Then so tall it grew it wore a crown of light,
But thieves from o'er the wall stole the seed by night;
Sowed it far and wide, by every town and tower,
Till all the people cried, 'Splendid is the flower!'

"Read my little fable, he who runs may read.
Most can raise the flowers now, for all have got the seed.
And some are pretty enough and some are poor, indeed.
And once again the people call it but a weed."

INFECTED GUN-SHOT INJURIES OF THE HIP.

BY LEO MAYER, A.M., M.D., NEW YORK.

In the October number of the AMERICAN JOURNAL OF ORTHOPEDIC SURGERY has appeared an unusually helpful report by Lieut.-Col. Osgood on the treatment of septic joints.

Two important questions are discussed:

First, whether a stiff joint is better than one in which slight motion, imperfectly controlled, is present;

Second, the question of the advisability of excision.

As a discussion of these questions is best brought to a focus by concentrating on individual instances, and as I have had occasion to treat in rapid succession five cases of septic arthritis of the hip, resulting from gun-shot injuries, it will, I think, be of value to report these cases in the order of their occurrence. From the individual data, thus presented, it will be possible to gain a picture of the pathology of the lesion and a concept of its treatment.

CASE REPORTS

CASE 1. T. M. Born September 19, 1877, was wounded November 18, 1914, by a large shell splinter which struck the inner aspect of the right thigh just below the hip and emerged on the posterior aspect. Examination in the Base Hospital two weeks after the injury showed the following: Wound of entrance 2½ cm. in diameter on the inner aspect of the right thigh 10 cm. below Poupart's ligament. Wound of exit in the gluteal region 8 cm. long, 5 cm. wide. A hand's breadth below the wound of exit, an incision 2 cm. long and 4 cm. wide connected with the wound of exit by a drainage tube. Retention of pus in all the wounds. Shattered bone palpable near the ramus of the ischium. Patient looked septic The temperature ranged from 101 to 102½°. Every movement of the leg was painful but there was no sensitiveness over the head of the femur. In the roentgenogram (see Fig. 1) the ramus of the ischium was seen to be shattered. There was no evidence of involvement of the hip joint.

FIG. 1.—Diagram illustrating the x-ray findings in Case 1 at time of admission.

December 5th, two days after admission, the wound of entrance was enlarged by an 8 cm. incision which was deepened through the adductors down to the ischium. Many necrotic bone splinters and bits of clothing were removed. The highly offensive odor was that characteristically found in the osteomyelitis subsequent to shell injuries.

Through a second incision on the posterior aspect of the thigh on the inner side of the sciatic nerve, the wound of exit was enlarged. A thick drainage tube was run from one wound to the other, and the ischium lightly packed. During the operation no evidence was found of injury to the hip. Despite the free drainage, temperature did not subside. The persistence of the characteristic odor suggested the probability of a progressive osteomyelitis of the ischium. Several days later, there was sensitiveness on the dorsal surface of the thigh external to the wound of exit, and from this wound it was possible to probe a pus pocket which extended upward in the region of the capsule of the hip. December 14th, nine days after the first operation, this pocket was opened by an incision on the outer side of the sciatic nerve, and drained. The temperature fell and for the next three days the patient seemed better. On the fourth day, however, the temperature again rose, although the wounds showed no retention of pus. It was impossible for the patient to locate the pain; nor was there, as yet, tenderness directly over the joint. Gradually a diffuse swelling of the thigh beneath the tensor fasciae femoris suggested the formation of another abscess. By the 30th of December this had become sufficiently definite to justify incision. Operation revealed a pocket extending from the posterior wound forward and downward beneath the tensor fascia and the vastus externus, half way to the knee. The abscess was opened its entire length, and lightly packed. Despite these three incisions and the ample drainage of all superficial pus pockets, the temperature chart persisted in showing an evening rise to 103°. The haemoglobin diminished to 45 and the patient continued to look extremely septic. On the 5th of January, for the first time, there was definite tenderness over the head of the femur. This fact, combined with a very slight swelling in the region of the joint, made the diagnosis of a purulent coxitis highly probable. Two possible courses seemed open: either to dis-articulate at the hip or to excise the joint. Simple drainage did not seem a logical procedure, because of the strong probability of an ascending infection of the bone. Both excision and amputation were bound to be coupled with shock, and the patient was too weak to stand much. Of the two procedures, the excision seemed to me the less dangerous. Therefore, after a preliminary blood transfusion, by which the haemoglobin was raised to 65, the hip was opened by a posterior excision corresponding roughly to the typical Langenbeck. The muscles inserting into the trochanter were cut away from their insertion and deflected upward, thus allowing ample exposure of the joint. The head of the bone was found bare of cartilage, the neck and great trochanter were eroded, the ligamentum teres was entirely necrotic, and the cartilage of the acetabulum looked worm-

eaten. There were a few drops of foul-smelling pus with the joint. The head of the femur, the neck and the entire trochanter were removed by sawing through the femur, just above the trochanter minor (see Fig. 2). It was now possible to examine the asetabulum more carefully. Pressure against the bone caused a little pus to ooze out and the removal of the superficial cortex revealed a generalized osteomyelitis. This extended over the entire area corresponding to the acetabulum, upward over the flare of the ilium to the origin of the gluteus minimus, downward along the descending ramus of the pubis to the point where the bone had been injured by the projectile and backward to the tuberosity of the ischium. This entire area of bone was removed with a large gouge (see Fig. 2). Particular care was paid to maintaining

FIG. 2.—The shaded area illustrates the extent of resection in Case 1.

the integrity of the periosteum on the deep surface of the bone. There was practically no haemorrhage during the operation, which lasted only 23 minutes. The pulse remained excellent throughout, and no shock developed subsequently. The thigh was abducted about 20 degrees, and 10 pounds traction was applied to the limb by adhesive plaster strapping. The patient's condition improved from day to day; the temperature fell gradually. At the end of two weeks it was normal. Four and six weeks later, there were slight rises of temperature owing to the formation of small abscesses, both of which were readily drained without general anesthesia. February 15, 1915, 38 days after the operation, the roentgenogram showed a restitution of the acetabulum and of the ischium. The shaft of the femur had rounded itself off and pointed in the direction of the acetabulum. Three months after

the operation all the wounds were healed and the patient was out of bed on crutches. The shortening of 6 cm. was equalized by raising the shoe, and the patient was soon able to walk with the aid of a cane. At the time of his discharge, he could flex the hip 90 degrees; abduct it 30° and walk three quarters of an hour without tiring. The gait was good with only a slight limp. One and a half years subsequently, I received word from him that he was at his old trade of upholsterer, and that he was able to climb a ladder as in the days before the injury.

Summary: This case is one of complete recovery subsequent to extensive purulent coxitis, developing secondarily to an injury to the ramus of the ischium. A satisfactory range of voluntary motion resulted subsequently to the operation. The shortening of 6 cm. could probably have been prevented, had the operation been performed before the great trochanter became involved. There is no question whatever, that the excision of the joint saved the life of the patient.

Case 2: Lieutenant H. Z., wounded June 14, 1915, reached my hands twelve days later. Despite the plaster spica which fixed the limb in the abducted position, he complained of severe pain in the left hip and in the left foot. Patient looked septic. The temperature ranged between 101 and 102½°. On the outer aspect of the plaster, a window had been cut, exposing a wound 20 cm. long. The edges were oedematous and unhealthy. When the plaster was removed, a healed wound of entrance was discovered in the left groin. Pressure over the head of femur caused intense pain and the discharge of several drops of pus through the wound of entrance. This was at once opened under local anesthesia, and a rubber drainage tube drawn through it and out of the wound of exit. The roentgenogram, (Fig. 3), showed that the

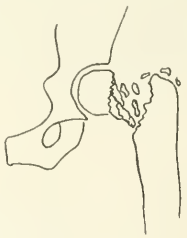


Fig. 3.—Diagram illustrating the x-ray findings in Case 2 at the time of admission.

head was lying free in the acetabulum. The neck of the femur was absent. Between the head and the trochanter lay a mass of fine bone splinters, evidently the remnants of the neck, which had been struck by the projectile. In the neighborhood of the great trochanter several other bone splinters were visible, the outlines of the trochanter were irregular and the shadow of the bone lacked the normal density.

Although the diagnosis of a purulent coxitis seemed certain, the operation was postponed four days, so as to give the nineteen-year-old patient a chance to recover from the effects of the long and wearing transportation from the front. The incision in this instance could not be made as in the first case, since it was advisable to expose the entire track of the bullet, so as to remove all the vestiges of clothes and other sources of re-infection. First an anterior incision was made on the outer side of the anterior crural nerve from the wound of entrance downward. The muscles were separated by blunt dissection, until it was possible to feel the fragments of the femoral neck. The wound of exit was then enlarged and, with a hand in each wound, it was possible to lift the entire muscular mass away from the shattered bone. The two longitudinal incisions were then joined by a transverse running directly below the anterior superior spine and the entire muscular mass deflected downward. In this way, the track of the bullet was exposed from one end to the other, and it was possible to remove numerous bits of clothing, which palpation had not revealed. The head itself was held in place only by necrotic shreds of the ligamentum teres, and was removed without the least difficulty. The acetabulum contained several centimeters of purulent fluid; abscesses were not present; the cartilage of the acetabulum showed no microscopic erosions. The great trochanter, however, showed purulent osteomyelitis and was removed with a saw-cut 1.5 cm. below its tip (see Figs. 4 and 5). The wound was lightly packed with gauze. Packings were brought out through

Fig. 4.—The shaded area indicates the extent of the resection in Case 2.

Fig. 5.—The necrotic head, neck and tip of trochanter removed in Case 2.

the anterior and posterior incisions. The muscle flap was drawn upward and fastened in place by five strong through-and-through sutures. Time of operation 45 minutes. Examination of the head revealed extensive degeneration of the cartilage, which in several places was lifted away from the bone. Sagittal section of the head showed that the infection extended from the cartilage downward into the bone. At the site where the femoral neck had been shattered, the bone was covered with a purulent membrane and from this place also a focus of bony infection could be traced extending 1½ cm. towards the head. The moderate shock, subsequent to the operation, was overcome by cardiac stimulation, combined with 500 c.c. of saline solution given intravenously. The temperature fell gradually. A week after the operation, the evening excursions were not over 100.4. As in the preceding case, a plaster of Paris dressing was not applied. The leg was abducted 15 degrees and held there with a traction of ten pounds. The convalescence was uneventful, except for a purulent arthritis of the left ankle joint. This was opened under local anesthesia and drained through two 1 cm. lateral incisions. Two and a half months subsequent to the operation, the roentgenogram showed a rounding of the upper end of the femur and the formation of a rudimentary head; there was no upward displacement of the femur whatever. The patient was discharged in December, six months subsequent to the injury. At this time he was able to walk a short distance without a stick. He could flex the thigh to a right angle and abduct it 40°. Total shortening was 2½ cm. (see Fig. 6). One year later the shortening had not increased. The patient was able to walk four hours without fatigue; he had climbed several mountains and was in active service in the Aviation Corps.

Summary: The significant facts in this case were (1) the prevention of para-articular abscesses by prompt surgical intervention, (2) the excellent functional result after extensive resection including 1½ cm. of the great trochanter, (3) the occurrence of a metastatic purulent arthritis of the ankle joint, as an indication of the pyaemia likely to be associated with infected gun-shot injuries of the hip.

Case 3: K. R., wounded September 23, 1915, by infantry projectile, reached the Base Hospital seventeen days after the injury. Wound of entrance, 2 cm. above Poupart's ligament (right) and slightly to the outer side of the great vessels; wound of exit on the right buttock; each wound about the size of a 25-cent piece. There was no pus retention, but the dressings showed the discharge of a serous fluid. The thigh was held flexed 90°, and the slightest attempt to straighten it produced marked pain in the hip joint. Rotation of even 1 or 2° was painful and there was marked tenderness to pressure over the head of the femur. It was clear, even without roentgen examination, that there had been an injury to the hip joint. The roentgenograms showed that the neck of the femur had been hit by the projectile. The head was lying free in the acetabulum, and was twisted slightly so as to point downward (see Fig. 7). The temperature never exceeded 101;

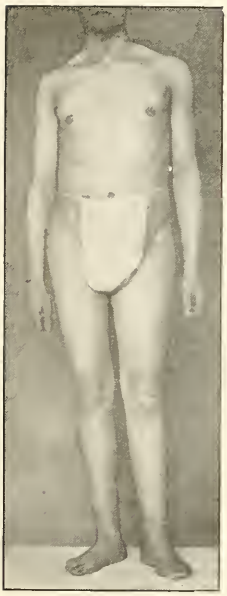


FIG. 6a.

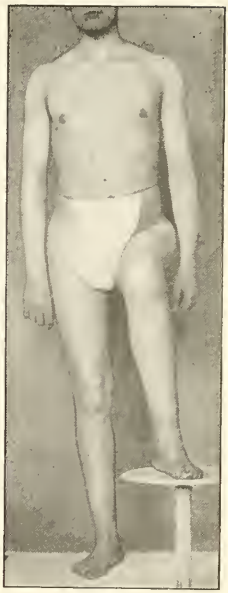


FIG. 6b.

Case 2 at the time of discharge. Shortening 2½ cm. Voluntary flexion 90°. Abduction 30°.

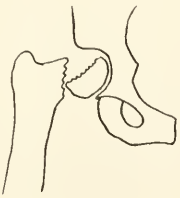


FIG. 7.—Sketch illustrating the x-ray findings in Case 3 at the time of admission.

The patient did not look septic. As his condition was in no way critical, a splint was applied, which fixed the leg in the pathological position, that is flexed to 90 degrees and slightly abducted, with the idea of a subsequent osteotomy to correct the position, provided the infection subsided. The splint was kept on three weeks; during this time the patient was practically free of pain during the day and had only moderate pain at night. There were no evidences of abscess formation, nor did the appearance of the patient change for the worse. The temperature, however, gradually rose and the roentgenogram, taken three weeks after admission, indicated absorption of the bone, with evidences of inflammation extending to the acetabulum. Operation was therefore considered necessary. The incision, a modified Kocher, was planned so as to expose not only the joint, but also the track of the bullet. The anterior portion of the wound was exposed by a separate, short incision, passing through the abdominal muscles above Poupart's ligament. The fibres of the gluteus-maximus were divided transversely; the gluteus-medius and minimus were drawn upward. With practically no hemorrhage and very little trauma, the hip was exposed in this way. The head and neck were completely shattered; the cartilage had almost disappeared; no pus was present, only a thick serous fluid. The head and neck were removed together with the other portion of the acetabulum which, as shown in the X-ray, was infected (see Fig. 8). Abscesses were not present and the cartilage of the acetabulum was normal, except for two small erosions. The trochanter was not infected. The track of the bullet was cleared of small splinters of bone and lead. The acetabulum and the bullet wound were packed lightly with gauze and the leg placed in abduction of ten degrees. The temperature fell by lysis. It did not become normal until one month subsequent to the operation. With the exception of a small abscess, the recovery was uneventful. Four months later, the patient was able to walk about. The hip, however, instead of being movable, as in the first two patients, was rigidly ankylosed. The functional result was, nevertheless, good, since the abduction just equalized the shortening of 3 cm. and enabled the patient to walk with only a slight limp.

Summary: Case 3 differs from the first two in the mild character of the infection, resulting in a serous rather than a purulent coxitis. Resection was indicated because of the gradual extension of the inflammatory process to the acetabulum. The resulting ankylosis was probably due to the fact that comparatively little of the trochanter was removed, thus allowing it to impinge against the roughened surface of the acetabulum.

Case 4. O. M., wounded the 10th of August, 1915, but did not reach the base hospital until the 8th of September. On the outer aspect of the left thigh was an irregular, purulent wound, about 6 cm. long, produced by a large fragment of shrapnel. The ex-ray demonstrated a shattering of the femur just below the great trochanter (see Fig. 9), with coxa-vara formation reducing the angle of the femoral neck to 90°. There was no tenderness over the head of the femur,

FIG. 8.—The shaded area indicates the extent of resection in Case 3.

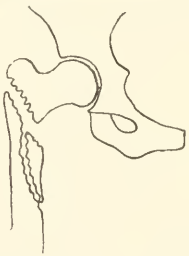


FIG. 9.—Sketch illustrating the x-ray findings in Case 4 at the time of admission.

nor other evidence of involvement of the hip. It seemed, therefore, to be merely a case of severely infected fracture of the femur. The leg was at once immobilized in maximal abduction by means of a fenestrated plaster dressing, enclosing the body to the nipple line. At first the temperature did not rise above 100.5, but gradually, despite careful dressing of the wound and the absence of pus retention, it rose, until by the 9th of October, the evening excursions had reached 103°. At this time, the patient began to complain of pain in the left hip and a slight swelling appeared over the head of the femur. It was impossible, because of the unhealed fracture, to test the movements of the hip joint; but even without these tests the diagnosis was clear. On the following day the operation was performed. The wound of

Fig. 10.—The shaded area indicates the extent of resection in Case 4.

entrance was utilized as the means of approach by prolonging it five centimeters upward and downward. The muscles inserting into the great trochanter were cut off near the bone; this permitted the easy extraction of the head, neck and trochanter. Frank pus was not present, but the joint fluid contained small, purulent flocculi. The cartilage of the acetabulum was discolored, but not eroded. As the upper end of the femur appeared to be infected, 2 cm. were removed by a transverse saw cut. There were no evidences of para-articular abscesses. The entire wound was packed, no sutures whatever were inserted. The temperature remained high. At the first dressing, a slight retention of pus, in the direction of the adductor muscles, indicated the need for further drainage. A counter incision was made on the inner aspect of the thigh and a thick rubber drain passed from the original wound, between the adductor muscles, and out of this second incision. As the upper part of the shaft of the femur was infected, and additional 7 cm. were removed (see Fig. 10). The following week the temperature persisted in its high evening excursion; the pulse was exceedingly weak. On the 20th of October, ten days subsequent to the operation, a few drops of pus were seen to ooze from an opening anterior to the joint. Under local anesthesia, an abscess between the tendon of the rectus muscles and the joint was opened. This, however, did not seem to be the only pocket, since several minutes after swabbing it out, it was seen to fill with pus. By pressure on various parts, this was found to issue from a minute canal, which passed upward on the outer side of the anterior crural nerve, beneath Poupart's ligament. This canal was laid open by an incision 10 cm. long, which

passed directly through Poupart's ligament and the abdominal muscles, revealing a retroperitoneal abscess the size of a child's head. One month subsequent the temperature had become normal, and at the time of the discharge from the hospital, May 4, 1916, the patient was able to walk for an hour without becoming tired. There was a shortening of 10 cm.; this was equalized by a cork sole. The patient could flex the hip 40°, abduct it 30° and rotate it 20°.

Summary: Case 4 represents a particularly dangerous and difficult problem, owing to the presence of the large retro-peritoneal abscess. This, unquestionably, was present at the time of the first operation and was responsible for the continuance of the temperature subsequent to resection. Probably much of the shaft of the femur could have been saved, had the abscess been discovered sooner. Significant is the excellent range of voluntary motion at the hip, despite the shortening of 10 cm.

Case 5: K. S., wounded May 20, 1915, reached my hands the 9th of June. Examination showed an extensive, irregular wound in the region of the right groin and thigh, about 20 cm. long and 12 cm. wide. The fascia covering the external oblique muscle of the abdomen lay bare in the mesial portion of the wound; at this point a pus pocket extended upwards. In the mid portion of the wound was a Y shaped pocket, which when probed led to bare bone. There was abundant purulent discharge. The x-ray showed a fracture just below the great trochanter, with marked upward displacement of the shaft of the femur (see Fig. 11). Pressure over the head of the femur caused

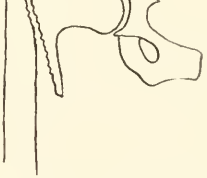


Fig. 11.—Sketch illustrating the x-ray findings in Case 5 at the time of admission.

no pain; the temperature did not range above 100.6. Despite traction of 40 pounds, it was impossible to overcome the upward displacement of the femur. Small abscesses formed in the neighborhood of the fracture, the temperature rose to 103°, the patient was so ill that his life was frequently despaired of, but a frank coxitis did not develop. At no time, despite rises of temperature to 103, was thera

swelling over the head of the femur, tenderness to pressure, or evidence of an abscess communicating with the joint. Operation was, therefore, considered contraindicated. Gradually the temperature fell, but not until five months later was it normal. A sinus about five inches long still discharged pus. This led down to the necrotic head of the femur through a 6 cm. incision, the sinus was opened and the head readily removed (see Fig 12). The acetabulum was found cov-

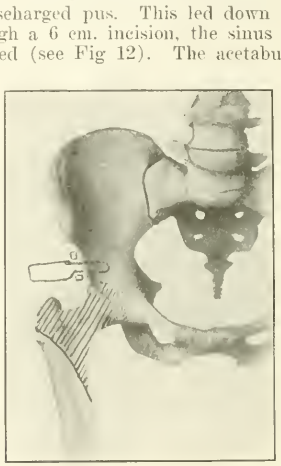


FIG. 12.—The shaded area indicates the extent of the resection in Case 5. Above the acetabulum is shown the bone graft inserted to form an artificial socket for the displaced shaft of the femur.

ered with healthy granulations, no pus was present. The wound now healed rapidly and the patient was soon out of bed. The functional result, however, was poor, owing to the fact that the shaft of the femur was displaced upward and had no hold against the pelvis. It was impossible to overcome the difficulty by traction or by directing the femur towards the acetabulum; therefore, I constructed an artificial acetabulum in the following way:—A transverse incision was made one-half inch above the tip of the femoral shaft. This was deepened through the muscles, down to the outer surface of the ilium; the bone was exposed just above the acetabular margin; with the largest sized Albee bone borer, an opening was made through the entire thickness of the ilium. A section of the cortex of the tibia was then removed, about 7 cm. long by 3 cm. wide. One extremity was narrowed and rounded with the reamer until it fitted snugly into the hole bored into the ilium. The transplant, when placed in position, held firmly. The small fragments of the bone, cut from the transplant, were placed

in the angle between it and the ilium. The wound healed by primary union. An x-ray, two months later, showed an effective buttress which prevented upward displacement of the femur and enabled the patient to walk distinctly better than before.

Summary: Case 5, in contradistinction to the first four, represents the type of arthritis in which, despite the high temperature, nothing was to be gained by an immediate excision of the joint. The septic symptoms were due to the severely infected comminuted fracture, not the joint involvement. It was, therefore, wiser to wait until the joint was walled off completely by granulations, before removing the necrotic head. By postponing the operation, the risk of operative mortality was markedly diminished. The poor functional result was due to the improper splinting during the transportation, which allowed the shaft of the femur to be displaced so far upward that it could no longer be directed towards the acetabulum.

The study of these five cases helps us to realize, that in dealing with infected gunshot injuries of the large joints, the first consideration is the life of the patient. Injuries to the hip, in particular, are to be regarded as among the most dangerous wounds of modern warfare. Extensive series of hip infections, dating from this war, have not, to my knowledge, been published thus far. Goebel reports a mortality of 60%, based upon experiences in the Balkan war. In the Spanish-American War, there was a mortality of 33 1/3%. Langenbeck, summarizing the results during the War of 1870, reported a mortality of 71% of those treated conservatively, 83% of those resected, 100% mortality in those instances in which an ex-articulation was performed. In deciding upon the best course of treatment, the operator should, I think, be governed by the principle of removing the pus focus as effectively as possible and with minimal shock to the patient. Simple drainage in the presence of a shattered, infected bone will not suffice. Disarticulation at the hip gives opportunity to clear away the septic focus, but the shock involved is very great. Excision is unquestionably the operation of choice.

HISTORICAL SUMMARY.

Resection of the head of the femur was first proposed by the English surgeon, Charles White, in 1769, who performed the operation only on the cadaver. The first operation on the living subject is credited to another English surgeon, Anthony White. The patient, a boy suffering from tuberculosis of the hip, survived the operation and the symptoms subsided. Oppenheimer, a German in the service of the

Russian Army, was the first to undertake the operation for gunshot injury to the hip joint (1829). For 17 days the progress of the patient was uninterrupted, then he succumbed to an intercurrent disease. The first successful case dates from the Crimean War. The patient, operated by the English surgeon, O'Leary, not only survived the operation, but was able to walk about with a fair degree of movement at the hip; there was a shortening of only 5 cm. Particular emphasis was given to this method of treating gunshot injuries of the hip joint by the classical report of our own surgeon, Otis, who, in 1869, collected 63 cases of excisions of the head of the femur performed during the Civil War, and 22 earlier cases. Although the mortality was very high—over 90%—he strongly advised this operation rather than exarticulation at the hip. He divided the cases into three categories: The primary operations, i.e., those performed during the first 24 hours, before the inflammatory reaction had a chance to develop; second, the intermediate resections performed during the period of most marked inflammatory reaction; third, the secondary operations, after the inflammatory reaction had ceased. This classification, which Otis adopted from Boucher, was justified: (1) By the marked pathological differences dependent upon lapse of time since the injury; (2) by the variation in the operative results during the three periods. This is made clear by a glance at the following table:

Resection	Total	Died	Mortality
Primary	39	36	92.3%
Intermediate	33	30	90.9%
Secondary	13	11	84.6%
	85	77	90.6%

Technique of the Operation: It is inadvisable to recommend a single incision applicable to all cases, since it should invariably be so planned as to expose not only the joint, but the entire course of the projectile. In two cases I employed vertical incisions posterior to the tensor faciae. In one case anterior to the tensor; in the other two cases, horseshoe shaped incisions were necessary. Whatever incision be used, the amount of damage to the muscles need not be great. The glutei and other muscles inserting into the great trochanter can be turned upward; in case the gluteus-maximus has to be divided, its fibers can be brought together at the conclusion of the operation.

Pathology: The essential in the management of these cases is a clear recognition of the pathology of the lesion. The purulent coxitis can arise either by a direct injury to the capsule or to the bones form-

ing the hip joint, or secondarily, by an excision from an adjacent focus. As an example of the latter type, witness the first case in which an injury to the ischium was responsible for the involvement of the hip joint. As soon as it is evident that the head of the femur is entirely separated from the shaft, one can assume with certainty in the presence of infection, that it will gradually become necrotic. The extent of involvement of the bones of the joint depends upon the grade of infection. When virulent, as in the first case, the entire acetabulum and portions of the ilium, ischium and pubis are likely to become involved. Particularly dangerous are the para-articular abscesses. They can form between any muscular planes and, owing to the diminished vitality of the patient, they are very difficult to detect. In addition to the gluteal region and the thigh, abscesses may travel upward beneath Poupart's ligament and involve the retro-peritoneal area. Their presence constitutes one of the most difficult phases in the after-treatment. It is advisable, at each dressing, to hold the wound wide apart with long, narrow retractors and explore each recess by means of strong artificial light.

Prognosis: With proper surgical care the lives of a great majority of patients should be saved and a satisfactory function should be secured. Whether a pseudarthrosis or an ankylosis results, seems to be of comparatively little significance. In all cases, with the exception of the last, a firm, weight-bearing joint was secured. The motion present was certainly of advantage to the patients.

Comparisons with Other Joints: It would be foolish to base the treatment for other joints upon this experience with the hip, since the problem involved is an anatomical one and each joint has so many peculiarities as to place it in a class by itself. Most nearly akin to the hip joint is the shoulder. Of four cases which I treated, in which the head of the bone was shattered and infected, I resected in every instance. One patient died of parenchymatous oozing from the entire surface of the wound. The other three recovered with pseudarthrosis and voluntary abduction, averaging 45°. Other cases which I saw, in which 5-8 cm. of the shaft had been sacrificed, were functionally poor results. At the elbow and at the wrist, I have always avoided resection by very free drainage anterior and posterior to the joint. The soft parts are lifted away *en masse* from the injured bones. In deciding upon the position of immobilization I follow the rules laid down by Sir Robert Jones. The knee joint has, in my experience, been the most difficult joint in which to control infection

Neither drainage nor excision availed in the majority of cases. In 12 cases out of 18 I was forced to amputate, to save the patient's life. At the ankle conditions are analogous to the wrist. By lifting away all the tendons from the joint, free drainage can usually be secured. When the astragalus has been shattered and the infection is severe, astragalectomy does not help. In three cases in which this measure was resorted to, amputation had to be performed soon afterward to control the sepsis.

Bibliography.

Alquier, P., and Tanton, J.: Traumatic Resection of the Hip for War Wounds (La résection traumatique de la hanche pour blessures de guerre.) Jour. de chir., Par. 1917, xvi, 113.

Baisch: Ueber Gelenkverletzungen. Münch. med. Woch., Vol. lxii, No. 27, p. 922.

Burckhardt and Landois: Erfahrungen ueber die Behandlung infizierter Gelenke im Kriege. Münch. med. Woch., Vol. lxii, No. 21, p. 723.

Exner: Kriegschirurgie.

Goebel: Ueber Hüftengelenkschüsse. Münch. med. Woch., Vol. lvii, No. 21, p. 721.

v. Langenbeck: Ueber die Schussverletzungen des Hueftgelenkes. Archiv. f. klin. Chir., Vol. xvi, p. 263.

O'Leary: Lancet, July 12, 1856, p. 46.

Oppenheim, Cited by Lehold: Ueber die Resektion des Hueftengelenkes. Wuerzburg, 1834.

Otis: Report on Excisions of the Head of the Femur for Gunshot Injury. Washington, 1869, Circular No. 2.

Payr: Gelenkverletzungen, Gelenkeiterungen und ihre Behandlung. Münch. med. Woch., Vol. lxii, Nos. 37, 38 and 39.

Pirogoff: Kriegschirurgie, 1864.

Pouchet: Treatment of Wounds of the Hip. Presse Médicale, December, 1917.

Syme: Treatise on Excision of Diseased Joints. Edinburgh, 1831.

White, A.: Descriptive Catalogue of the Pathological Specimens in the Museum of the Royal College of Surgeons, London, 1847, Vol. ii, p. 230.

White, Chs.: Cases in Surgery. London, 1770, p. 66.

A REPORT ON THE CLEVELAND AND ELYRIA CRIPPLE SURVEYS.*

BY WALTER G. STERN, M.D., CLEVELAND, OHIO.

The Cleveland Cripple Survey grew out of questions in the minds of people interested in child welfare work, as to the general condition and industrial chances of the handicapped.

The Committee on Cripples making the survey was composed of representatives from the Cleveland Foundation, the Cleveland Welfare Council, the various hospitals, dispensaries and social agencies caring for crippled children, the public and parochial schools, the Anti-Tuberculosis League and the several foreign consulates.

The purpose of the Cripple Survey was to discover the economic and educational needs, the capacities and possibilities of the children and adults in Cleveland who are handicapped because lacking the normal use of the skeleton or skeletal muscles, and to make such recommendations for meeting these needs, as the facts brought out by the survey may suggest.

A cripple is defined for the purpose of the survey as "a person whose muscular movements are so far restricted by congenital defect, results of disease or accidents as to affect his capacity for self-support." The heart cripple and the blind have been excluded.

The hospitals, dispensaries and social agencies contributed the original list of cripples. A certain poor district of the city known as the "Lake" district, inhabited chiefly by immigrants from the Austro-Hungarian Empire, was posted as the first district to be canvassed. More than 65% of the total number of cripples found in this district were *not* on the original list of cripples, but were discovered by the house-to-house canvass. This method was then applied to the whole city. For convenience, the city was divided into eight districts, and a preliminary report secured from practically every family in the city, rich and poor alike. A schedule of questions was then filled out by the more experienced workers on a follow-up visit.

A total of 4,186 schedules were collected by a staff of 38 workers, in 12 months. For the past 12 months a summing up of the schedules and an analysis of the figures has been going on; the complete report is now published and can be secured by those interested, from the publishers or the Cleveland Welfare Council.

The analysis gives not only information as to the size and nature of

* Read at the Pittsburgh meeting of the American Orthopedic Association, May, 1917.

the problem, but practical guidance toward a community plan for promoting the welfare of the cripples.

The collecting of the schedules was found to be very easy. We had both amateur volunteer workers, mostly students of sociology in the local university, and more experienced, paid social workers. The acceptance of them in all neighborhoods was most pleasant and reassuring with only a few exceptions; probably less than 100 out of approximately 150,000 families, refused to give any information. When one considers the various types of people in the different economic classes, and the fact that they were calling upon our own initiative rather than by request, the results seem almost beyond expectation. Many families were genuinely interested in the work and voluntarily wrote to the office expressing their approbation and offering to assist in any way that was within their means. The news of the canvassing spread from one street to another, and from one end of the city to the other with rapidity, and, fearful that they might not be included in the canvassing, parents, or brothers and sisters, telephoned or called at the office to give the names of cripples in their families; and it was apparent that they were not looking for material help, for this was often from families where the cripple was entirely self-supporting. Sensitive cripples and those of the reclusc type were glad to give anything from their experience, however encouraging or discouraging, if it would be helpful to other cripples. Many fathers voluntarily took their dinner hour to come to the office to give information about their crippled children, and to ask advice about a normal plan for their future. A few pathetic letters have come from outside the city, where cripples had learned of the work through the newspapers.

The canvassers prepared the way for the trained survey workers, and the second visit, instead of being considered a nuisance, was welcomed with interest, and it was most evident from this spirit that the canvassers had been both tactful and friendly in their approach to the families and had gained their coöperation. It was with genuine regret that many of the workers finished this part of the work, which seemed at first so difficult, but proved to be an interesting and unusual opportunity.

In all 4,186 survey cards for tabulation were completed in 12 months, at a cost of $8,505, and it was estimated that to complete the survey another $4,000 would be needed, which estimate has been shown to be approximately correct, so that it has cost a total of $12,500 to complete this survey of 4,186 names.

It was established that 65% of our cripples were not known as such to the public free dispensaries, charitable and other social agencies. This condition is surely local and is most easily explained. Cleveland is an industrial city of 750,000 people; its industries are so diverse that industrial stagnation is never quite so acute in times of business depression as in other centers, such as Pittsburgh, Birmingham, Minneapolis and others, which depend chiefly upon one or two great industrial branches. Although it is the second center in the United States for the garment and clothing trades, sweat-shops are practically unknown. The laboring class live chiefly in detached houses or cottages situated on lots of ground averaging about 25-100 feet in area, and the building code is so extremely rigid that the unhygienic tenements so unfavorably known in many of our large cities are practically unknown. Despite the extremely large foreign population (it is estimated that immigrants from the Austro-Hungarian Empire and their descendants comprise over 50% of our population), extreme poverty is rare. Then, too, charity, hospital and dispensary abuse (by those able to pay for medical treatment), such as is so prevalent in many large cities, notably New York and Philadelphia, has been entirely wiped out by a vigorous campaign on the part of the local Academy of Medicine and by the coöperation of the hospitals and dispensaries in a charities clearing-house. With this charities clearing-house in operation, no unworthy applicant can receive free treatment, nor can a free patient run from one hospital or dispensary to another, as so many wish to do; daily reports are made and sent out and repeaters and floaters have been absolutely eliminated. Every applicant for free medical attention must show his need for same. In any case of doubt the applicant is favored; but a special investigator, preferably one speaking the language of the applicant, is given the card to investigate. In this way the expenses of treating impostors and of having patients treated by more than one agency at one time have been eliminated and organized medical charity has been made more efficient and effective.

A few of the interesting findings of the survey are as follows:

Ratio of cripples to population, 6 per 1000 inhabitants.

Age at Time of Survey.

Under 5 years	165	
" 10 "	416	936 or 22%
" 15 "	355	
From 15 to 60 years	2553	or 61%
Over 60 years	697	or 17%

Color and nativity followed the figures of the population for the city at large.

AGE AT OCCURRENCE OF DISABILITY.

Birth or under 5 years	1400	33%
From 5 to 10 years	352	8%
" 10 " 20 "	546	13%
" 20 " 30 "	509	12%
" 30 " 40 "	395	9%
" 40 " 50 "	370	9%

Forty-three per cent. of the whole group became crippled during working age. 33% became disabled under the age of 5, while 50% became crippled before the age of 15. The problem of the cripple is first one of childhood and second of working life.

AGE OF OCCURRENCE.

FORM OF DISABILITY		NUMBERS						
		Total	Under 5	5-14	20-49	50-59	60 and over	Not stated
All forms		4186	1400	646	1274	294	273	47
Loss of hand or arm	One	188	5	24	112	10	3	0
	Both	6	0	0	4	1	0	0
Defect of hand or arm	One	499	101	63	223	29	10	5
	Both	42	15	3	14	6	2	0
Loss of foot or leg	One	466	19	114	244	19	16	1
	Both	27	1	4	19	0	1	1
Defect of foot or leg	One	1546	706	274	292	98	98	16
	Both	365	163	26	84	39	40	6
Loss or defect of one or both upper and of one or both lower limbs		332	115	24	103	33	51	1
Deformity of body		199	122	52	10	2	5	5
Paralysis of body		6	1	0	3	1	0	0
Both		0	0	0	0	0	0	0
Not classified		67	20	29	13	1	1	2
Disability of upper or lower limbs, or of both and the body		443	132	33	153	55	46	10

MAIN CAUSES OF DISABILITY	NUMBERS		
	TOTAL	MALES	FEMALES
All causes	4186	2638	1548
Congenital	301	136	165
Accident at occupation	468	457	11
Other accident	1323	966	357
Infantile paralysis	525	289	236
Other diseases	1437	724	713
Not stated	132	66	66

To summarize: 301, or 7%, of the disabilities were due to congenital causes; 1791, or 43%, to accident; 1962, or 47%, to disease; and in 132 cases, or 3%, the cause not learned.

Causes in Children below Age of 15.

Congenital	149	16%
Accident	87	9%
Infantile paralysis	382	41%
Tubercular joints and bones	139	15%
Other diseases	148	16%
Not classified	31	3%

Attendance of Children at School.

Form of Disability		Total	Regular Classes	Special Classes	Not at School
All forms		771	415	110	246
Loss of right arm	Below elbow	0	0	0	0
	Above elbow	1	1	0	0
Defect of right hand		11	7	1	3
Defect of right arm		12	9	1	2
Loss of left hand		1	1		
Loss of left arm	Below elbow	1	1	0	0
	Above elbow	0	0	0	0
Defect of left hand		12	11		1
Defect of left arm		18	15		3
Loss of both hands		2	2		
Loss of both arms		1	1		
Defect of both hands		5	4	1	
Defect of both arms		3	2		1
Loss of foot		8	7	1	
Loss of leg	Below knee	10	9	1	0
	Above knee	12	8	1	3
Defect of foot		44	26	4	14
Defect of leg		324	198	36	90
Loss of both feet		0	0	0	0
Loss of both legs		0	0	0	0
Defect of both feet		10	8	1	1
Defect of both legs		78	13	24	41
Loss or defect of one or both upper and one or both lower limbs		68	36	12	20
Deformity of body		68	34	11	23
Paralysis of body		1			1
Not classified		30	12	5	13
Disability of upper or lower limbs, or of both limbs and of body		53	12	11	30

Occupation (above Age of 15).

Form of Disability		Number At Work	Number Not at Work
Total		1912	1338
Loss of hand or arm	One	147	37
	Both	3	2
Defect of hand or arm	One	341	86
	Both	20	15
Loss of foot or leg	One	314	115
	Both	14	13
Defect of foot or leg	One	721	389
	Both	81	165
Loss or defect of one or both upper and of one or both lower limbs		76	174
Deformity of body		73	53
Paralysis of body		3	2
Not classified		10	27
Disability of upper or lower limbs, or of both and of body		109	260

Occupation	Numbers Male	Female
Total	1319	593
Manufacturing and mechanical industries	615	77
Transportation	192	10
Trade	201	24
Public service	65	1
Professional service	45	16
Domestic and personal service	80	44
Clerical occupations	49	21
Not classified	36	0
Housewives	0	400

Ability to Work (above the Age of 15).

	Number Total	Male	Female
	2553	1738	815
I. Not seriously handicapped for normal occupation	753	566	187
II. Able to work at selected trades and processes	1142	835	307
III. Disabled (*i. e.* for work alongside normal persons)	658	337	321

Reasons for Unemployment.

	Number Total	Male	Female
	859	543	316
A. Need of placement at selected trades and processes	189	133	56
B. Need of special training or special conditions of work	130	108	22
C. Need of home or hospital occupation	45	15	30
D. Not classified	495	287	205

CONCLUSIONS FROM STUDY OF SURVEY.

A. Children.

"1. The problem of the crippled population is first of all a problem of child welfare. Although the adults were more numerous than the children—more than three times as many—a fourth of the crippled population were not only under the age of 15 at the time of the survey, but a third of adult cripples became disabled while under the age of 15. Thus a total of 49% of the whole group were disabled in childhood.

2. As a children's problem it is essentially a medico-educational one. The nature of the causes and the form of the crippled condition, the consequent length of time and well-known conditions of life and treatment needed to minimize the handicap, require that provision for medical and educational care be planned in close relation to each other.

3. The varieties of muscular and skeletal defects are so many, and crippled persons, like normal ones, have so great a variety of aptitudes, that no single or simple means will satisfactorily provide for their vocational preparation.

4. The existing special provisions for the care of crippled children are inadequate, especially in their equipment for correlating medical and educational care and for fitting crippled children for working life.

B. Adults.

5. The problem of the crippled population is, secondly, a problem of adults in working life. The number who are over 60 years of age is small, the number of these who became crippled after 60 is still smaller. But the number becoming crippled during working life by accident, especially of men, is large, and the number crippled from all causes very large.

6. Cripples in Cleveland, under heavy physical handicap, in direct competition with others, and without special favor of the community, have reached and held remarkable positions of economic independence. Their capacity, occupations and earnings point on the whole to varied and normal tendencies of life.

7. The great variety of forms of handicap and notable difference in aptitudes and experience prior to becoming crippled, point to the need of a most flexible system of service to those among cripples who cannot make their way unaided, but who may be benefited by special plans for their rehabilitation and reëducation.

8. The increased care with which, under existing laws, employers

tend to avoid the added risks of liability in employing physically handicapped labor, place the handicapped, however capable they may be, at an increasing disadvantage, except at times and in places where other labor is difficult or impossible to secure.

RECOMMENDATIONS.

In order that the needs of both adults and children in Cleveland may be met, *a central bureau*, or federation of agencies interested in cripples, is required, that would represent not only existing agencies especially instituted for cripples, but all the forces touching their lives most closely—medical, educational and industrial. Its program should be carefully worked out for the "long run" on the basis of the facts brought out by the survey and considered both in the light of local resources and the experience of other states. Such an organization should, among other things, work for adequate medical-educational care for crippled children closely correlated with the school system; devise the various means of safeguarding the interests of crippled adults (or aim at a separate organization to be devoted to those ends); and secure (provide, if necessary) the training of workers able to carry out its program. The "various means" for adults will include legislation adjusting, for employer and employee alike, all matters of compensation and insurance that now stand in the way of reëmployment; provision for the application of all that has been learned through the war of use of appliances, and early vocational estimates and preparation, as well as the more familiar principles of occupational therapy in the convalescent period—provision for industrial training for the competent among the handicapped as a part of an adequate system of industrial training for all citizens; special provision for placement of those who cannot place themselves and for the special employment or home-industry of semi-invalid cripples capable of taking some small part in active life. Above all, and through all, this work must run the purpose of preventive effort to forestall crippled conditions from accident, infantile paralysis and other disease—study, educational campaigns and legislation, if necessary, that no needlessly crippled persons shall be added by disease or accident to the population."

While this was being done in Cleveland, another survey of quite a different kind was made by the trustees of the Gate's Hospital for Crippled and Deformed Children, of Elyria, Ohio, of which I am the

directing orthopedist. The hospital is situated 25 miles west of Cleveland, in the City of Elyria, in Lorain County, Ohio.

When the suggestion was made to the trustees of the Elyria Memorial Hospital Association to build and endow a hospital for crippled children, it was deemed best to make a canvass of Lorain County to see how great was the local need for such an institution. This was done by canvassing all the schools and school children, physicians, charitable and church organizations, Sunday schools, etc. No house-to-house canvass was made, but the enumeration must have been most complete, as witnessed by the greater proportion of crippled children found, over the number reported in Cleveland. Only cripples under the age of 14 years were tabulated, because it was felt that in an institution, such as was proposed, the greater good could be accomplished by limiting it to children.

In Lorain County, population, 100,000, were found 251 crippled children; ratio, 1 to 400 of population. They were mainly situated as follows:

Lorain City, population, 40,000; 105 crippled children; ratio, 1 to 381. Prosperous industrial city. Iron and steel foundries, ship building and coal docks; 35% foreign population.

Elyria City, population, 20,000; 55 crippled children; ratio, 1 to 364. Manufacturing city. Steel and iron specialties. Small foreign population.

Amherst Village, population, 2,500; 18 crippled children; ratio, 1 to 150. Stone quarries. 85% foreign population. Hygienic and industrial conditions very poor. Recent epidemic of infantile paralysis

Oberlin City, population, 4,500; 14 crippled children; apparent ratio, 1 to 320; real ratio, 1 to 525. No manufacturing. College center, with 3,000 college students not enumerated in above population estimate. Hygienic conditions excellent.

Wellington, population, 2,500; 12 crippled children; ratio, 1 to 209. Farming community. No manufacturing. Recent epidemic (1915) infantile paralysis.

Practically 50% of all the cripples of Lorain County were found in families who could not afford to pay for the proper medical treatment and education, even if proper facilities could be provided. This led to the building of a 45-bed orthopedic hospital in the City of Elyria, on the spacious grounds of the Elyria Memorial Hospital. To more correctly determine what calls would be made upon it by other counties and to decide in reference to the future growth of the insti-

tution, it was deemed best to make a similar census of the adjoining counties, from which we have learned as follows:

Erie County, population, 46,000; 117 crippled children; ratio, 1 to 393. Chiefly agricultural; some light manufacturing in the City of Sandusky. Very small foreign population.

Sandusky County, population, 41,000; 73 crippled children; ratio, 1 to 564. Strictly agricultural district. No recent epidemic of infantile paralysis. Living conditions excellent.

Huron County, population, 40,000; 101 crippled children; ratio, 1 to 396. Chiefly agricultural; some light manufacturing. Very small foreign population.

Ottawa County, population, 23,000; 52 crippled children; ratio, 1 to 442. Rich agricultural and fishing community; a few cement and gypsum mills. Very small foreign population. No recent epidemic of infantile paralysis.

It is thus estimated that in an agricultural and manufacturing center, when people are prosperous and where living conditions are good, without having had a recent epidemic of infantile paralysis, the ratio of crippled children to population is about 1 to 400; where the people live under unhygienic conditions, or where there has been a recent epidemic of infantile paralysis, the ratio of crippled children to the population may increase in these centers to as high as 1 to 150 of population.

In making this last survey we did not feel the necessity of analyzing every case. It was simply an enumeration made for the purpose of finding out the number of crippled children, where they were located, what class of homes they came from, how many would be charity, how many would be part charity, and how many could pay. We found that in taking this survey, which was done by one trained person in nine months, at the expense of approximately $500 for this part of the work, that the expenses were paid tenfold by the interest the various communities took in the work, and the donations made for the support of beds by the counties investigated.

TARSAL TORSION IN WEIGHT BEARING.

BY WILLIAM JACKSON MERRILL, M.D., PHILADELPHIA, PA.

Much has been written concerning the arches of the foot. The analyses of their conformation and relation to function are somewhat contradictory. One finds in the anatomical delineations of many writers a very consistent exposition of the structures which compose the various arches. In the true sense, the structures of the foot do not conform to the principles of a true arch. First, because a true arch, mechanically, is composed of similar segments forming a curve to span a given space, transmitting their own and superimposed weight mutually, transforming the vertical to a lateral stress, and rest upon fixed abutments. Secondly, the arrangement of the bones and soft parts is analogous to the principles of a suspension span, the sustaining cables being the extrinsic muscles chiefly and the intrinsic muscles to a lesser degree. The plantar ligament replaces the sustaining force of the abutments of the true arch, but the structure formed in this manner is a flexible suspension principle rather than a rigid fixed support, and inasmuch as it is a flexible and slightly elastic structure, depending in its supporting force upon the foot muscles, it enters into the complex structures of the foot as a suspension fundament.

Granting that these values of the component elements of the foot are true, the structural importance of the suspension elements is greater than that of the supporting levers. In the correction of static defects, the attention should chiefly and primarily be directed to the abnormal condition of the soft parts. Undoubtedly the misleading expression "broken arches" originated in a conception of a true arch principle and that the flattening of the foot occurred because of a break in a given arch. When this notion predominates and the constitutional cause and the muscle disorders are ignored, the fallacious practice of simply "propping up the arch" often is employed.

The physiological and mechanical integrity of the foot is preserved or altered proportionately as the forces are applied to it in the normal direction of weight-bearing force or in planes deviating from the normal; therefore, the importance of alteration in the normal static relationship of legs, thigh, and pelvis must be reckoned with. Assuming that the weight is borne equally and reciprocally on the extremities, and that the normal gravity stress is altered, definite mechanical deviations will follow in the structures below the part which has been

affected. If the pelvis be rotated backward, the entire lower extremities tend to rotate outward, and the maintenance of this change is apt to continue with a toe-out position of the feet. If this change be continued, the toes deviate farther from the sagittal plane, increasing the added cross strain to the tarsus, plus the stress of weight bearing. Weakness of the external rotators of the legs allows the thigh and leg to rotate inward, whether or not the feet maintain their normal direction, but there is a change in the stress of the foot brought about by deviations in the line of weight bearing. The strain noted, plus the added torsion stress, is especially severe when relaxed knee joints are slightly bent, and when pronated and flattened feet coexist. The deviation of the toes increases proportionately with the position and condition of structures mentioned, and when constitutional maladies coexist, structural and mechanical alterations progress. When the normal relationship of the structures of the foot is altered, there is certain definite movement of the component parts. The os calcis rotates on three axes: forward on the transverse, inward on the vertical and longitudinal. The scaphoid rotates backward on its transverse, inward on its longitudinal and vertical axes. The inward rotation of the os calcis on its longitudinal axis varies in proportion to the relaxation present. The altered position of the os calcis measured by its deviation from the normal range of motion may be taken as an index of the flattening of the foot. Normally the lateral play of the astragalus is slight, but the anterior breadth of its trochlear surface is slightly greater than its posterior breadth. When the forward and downward movement of the os calcis and astragalus occurs, the lateral play is increased, adding another factor to the flaccidity present. The lateral movement of the foot is greater when the foot is extended than when it is flexed on the leg, owing to the cuneiform shape of the trochlear portion of the astragalus and the increased tension of the lateral ligaments. When the subastragalar movement in a joint is increased by the relaxed state of the soft parts, there is a greater deviation of the os calcis from its normal play. The movement in the midtarsal joint carries the midtarsus to a lower plane and the proximal heads of the first four metatarsal bones move inward with abduction of the antitarsus, owing to the obliquity of the midtarsal joint.

The antitarsus has been defined as the structures anterior to the mediotarsal joint, but the tarsus is composed of the bones of the foot posterior to Lisfranc's line. The article, for convenience sake,

refers to the bones anterior to that line as the antitarsus, dividing them into five segments, each composed of a metatarsal bone, its phalanges, and the tarsal bones which enter into its continuity.

The longitudinal arches may be considered from this point of view of two groups: the first, three segments abutting against the scaphoid as a keystone; the second group, the fourth and fifth segments abutting against the cuboid as a keystone. The first four segments have a definite arch. In the normal position of weight bearing, the five metatarsal bones rest upon the ground and therefore act as abutments. These arches diminish in curves outwardly. When the distal ends of the metatarsal bones spread beyond their normal range, the plane of the arches is deviated from the normal, adding a weakening factor. The transverse arch formed by the proximal heads of the metatarsal bones is of importance, since it is the confluence of stabilizing forces of the foot. The arches taken collectively form a segment of an inverted dome. The os calcis and astragalus, the complement of the metatarsal segments, depend for their position upon the muscles chiefly. The arches formed by the antitarsal segments are supported by their complement of the dome, at the scaphoid and cuboid.

In walking, the oscillating movement varies the line of gravity. The normal weight-bearing position of the lower extremities in standing places the structures in such a position that the plane of weight-bearing force passes through the center of the head of the femur and a point inward to the center of its condyles, slightly inward to the center of the lower end of the tibia, the astragalus and the os calcis, outward to the center of the scaphoid and great toe. The axes of the legs should be parallel; the inner malleoli should be separated about one-third the distance between the heads of the femora, and the longitudinal axes of the feet should be parallel. The fixed supporting points are the lower surface of the os calcis, the tuberosity of the fifth metatarsal bone, and the distal heads of the metatarsal bones.

This article does not take cognizance of an anterior arch since in normal feet the distal heads of the metatarsal bones transmit pressure directly to the ground and do not so conform as to mutually transform the vertical to a horizontal stress, and do not have a substructural element to act as abutments.

Under normal conditions, the curve of the longitudinal arches is in a vertical plane, and stress is applied in harmony with the plane of weight bearing. When pronation or flattening or both takes place and the proximal heads of the metatarsal bones move inward, the sup-

porting power is diminished proportionately as the deviation. Increased strain is imparted to the sustaining soft parts. As the midtarsus and the proximal heads of the metatarsal bones are displaced mesially, inward rotation of the first four metatarsal bones takes place, imparting a torsion stress to the metatarsal bones and the midtarsus, and adds abnormal strain to the supporting ligaments. If the movement of a joint, even when it is in a normal condition, be carried to its physiologieal limit and held there for any considerable period, mechanical irritation is set up and vaso-motor changes occur, the inherent nerve filaments are stimulated and pain is induced locally or may be referred to other parts.

The pain varies proportionately as the amount of stress and the continuance of the extreme movement. Pain resulting from the torsion of the tarsus is localized at the point of greatest stress or is referred forward, which is more generally the case, and may be periodical or continuous. When this torsion stress is maintained and the flaccid, extrinsic and intrinsic muscles are overstimulated, muscle fatigue takes place, and strain pain is induced. When a structure is irritated, there is a voluntary or subconscious effort to so alter the position or relationship as to protect the threatened part. Irritation of the soft parts of slight internal strain of the foot structures can set up violent action of a muscle or group of muscles, and produce strain and spasm pain of an intense degree, and the trivial cause be overlooked, when the two conditions are remote. Continued hyperstress will bring about tonic spasm followed by exhaustion, loss of tone and power, and muscle flaccidity. The damaged muscle is urged to carry the normal load which is beyond its power and the overstimulation applied to it becomes a potent irritation.

The foregoing discussion is applied to flaccid, weak feet, in which there is an inward torsion. Outward torsion of the tarsus is found in feet more or less contracted. In such feet, the torsion mechanism is the reverse of that of the flaccid foot. Here is found an increased arch, a shortening of the plantar ligament, spastic contracture of the posterior muscles, especially of the posterior tibial, which often maintains such a force as to tilt the os calcis backward, partially subluxating upward the os calcis on the cuboid. Spasm of the long flexors of the toes adds another factor in the outward torsion of the foot, because they contribute a considerable force in supination.

Clinically the flaccid foot is found more frequently than the contracted type. It seems beyond peradventure that these complex con-

ditions are positive factors in the production of pain in the muscles, also pain variously located about the tarsus, and the extensively discussed pain of the anterior metatarsal region.

Treatment: The treatment of postural defects is primarily the removal of constitutional predisposing factors, since static disorders unassociated with some systemic malady are in the minority; and secondarily, treatment consisting of improvement of affected structures with the use of mechanical devices.

Constitutional maladies have a direct relationship to static defects. They can always be determined and in the majority of cases, can be corrected. Malpositions in weight bearing, improper shoes, inflammatory conditions of the integument, joint structures, ligaments and muscles must first be alleviated. As soon as the foot structures warrant it, the tone and power of the muscles should be improved by massage, local applications and exercises. Static defects, such as the internal rotation of the legs and malposition of the pelvis, should be corrected by exercises and the practice of good posture. The maintenance of good posture in weight bearing to minimize the strain in the performance of function is most essential. The habit of "toeing straight" or slightly inward, with the encouraged use of the supinator muscles, throws the weight to the outer line of the foot and diminishes the strain on the inner, weaker side of the foot.

Rest will decrease the period of convalescence when it can be practised, but the majority of patients must continue their vocations, and mechanical devices must be employed to sustain the therapeutic measures until the rehabilitation of normal health and function have been established. At this juncture mechanical devices should serve their temporary purpose. They are almost infinite in variety and are widely used. Arch props are incompatible with the physiological and mechanical principles of treatment. A slightly flexible and elastic support acts more harmoniously with physical structures, since nature abhors rigid coercion.

Extreme pronation can be most satisfactorily corrected by a sling support which is secured by an upright on the outer side of the foot and leg, to act independently or in conjunction with shoe supports. Mild pronation needs simply exercises alone, or combined with shoe devices. A means which exerts pressure directly upon the ankle creates discomfort and abrasions.

When a device is placed under the foot for the correction of any one or more of the postural defects, there are certain very important

points which should be taken into consideration. This article has laid emphasis on the discursions of the segments of the tarsus and antitarsus, and emphasizes the importance of reversing these abnormal movements in the correction of static defects.

When simply pronation exists, the fault is generally in the muscle structure. Flattening is primarily due to the muscular affections. In taking into account both conditions here, physiological errors, not traumatism in its gross sense, are considered.

The discursions of the os calcis are favored by the relaxation of the plantar structures, but they may occur when these structures are intact. In any case, the os calcis may be taken as the keynote of normal position of the foot and as a starting point, both of the defect and its treatment. It follows, then, that the device employed must so act as to reverse the discursions. Whatever means is employed, it must be so organized with the shoe as to give stability. A device within the shoe and not firmly fixed to it furnishes a wabbly support. Granted that the associated deviations commenced with the os calcis, correction may begin with it. The following constituents of the shoe are essential: A closely fitting heel with stiff counter, a pliable upper which is roomy beyond the vamp seam, a boxing and cap if desired. The top should fit in such a manner that when laced it will not constrict the ankle or hamper movement. The vamp seam should not be placed anterior to the proximal margins of the heads of the metatarsal bones. A wedge, base inward, is placed under the heel; the head is floated inward and extended forward; the inner counter is carried as close as possible to a mid point on the inner surface of the os calcis; the shank must be securely fastened to the heel and practically cover the space within the rand. It should have a mild spring temper and be thick enough to sustain the weight without yielding permanently. It is carried forward to rest upon a prism, so placed that its anterior margin engages well with the posterior contour of the metatarsal heads. The prism must be secured to the shank in order to accomplish a stabilized relationship with the heel. On account of the mild malleable qualities of the shank, increased support can be applied to the foot at the desired point from the heel to the ball by bending the shank. If the heel and ball support are not mutually fixed, the thrust of walking and uneven surfaces permit a divergence of their function and a twisting of the foot. The essentials of this method may be placed within, but must be secured to, the shoe. The fifth antitarsal segment is normally on the ground. Any

device which raises the distal end of the metatarsal bone, tilts it in such a manner as to strain the metatarso-phalangeal joint and to force it against the upper of the shoe; therefore a prop at this point should be combined with a lift under the proximal end to raise it disproportionately, or it should remain parallel with the ground.

The writer was afflicted with tarsal strain and its consequent pains. In order to know the sensations of treatment, he employed every conceivable means of relief. Many of them relieved the astragalar cuneiform pain and lessened the metatarsal pain, but the device which tilted up the distal end of the fifth metatarsal bone created an unbearable pain in its distal joint. This pain ceased after the use of the following wedge: Two truncated prisms were so placed that the maximum thickness was on the mesial edge of the sole. It tapered forward and backward to a thin edge and outwardly diminished gradually to the fifth metatarsal bone, where it was shaped to leave a depression in the insole as a bed. This mesial bi-prism was secured to the shank, having on its upper surface a steel plate to receive the shank and below a sheet of rubber to prevent squeaking.

In the majority of cases is it not a fallacy to place a wedge with its base inward under the ball of the foot? The discursions of the tarsal bones in pronation and flattening of the foot created a divergence of the transverse axes of the tarsal segments and the ball of the foot. If a wedge be placed under the latter, this divergence is increased and it follows that the strain is made greater. The normal position of the ball of the foot is parallel with the ground and should remain there, except when inflammatory conditions make it impossible, and the foot *in toto* should be tilted.

In conclusion, the writer desires to state that static pains, localized in various parts of the foot, have been relieved when torsion of the tarsus and antitarsus was erected and no other measure employed; it therefore seems fitting to recall the emphasis laid upon the action of torsion stress and its correction by producing reverse movements to the discursions in the various segments of the foot.

PRODUCTIVE OCCUPATIONAL THERAPY IN THE TREATMENT OF THE DISABILITIES OF THE EXTREMITIES.

BY E. G. BRACKETT, COLONEL, MEDICAL CORPS, U. S. A.

One of the lessons which has been learned from the experiences in treating the injuries of this war is the importance, in conjunction with this, of the preservation of function. The amount that can be done has been demonstrated and also the need of the very early application of the principles of the treatment necessary to accomplish this end. The principles of this treatment for the preservation of function are not new, nor are they but recently recognized, having been in use for many years, although with rather a limited application; but a wide application of these principles, which has been necessary in the peculiar kind of injuries received in this warfare, has made their recognition imperative. More has been accomplished in the last few years by the wide application of this method than in several previous decades, and it furnishes opportunity for establishing on a permanent basis the importance of this phase of treatment for the class of injuries which may develop deformities, stiffness and atrophies, either primarily or in the course of slow recovery.

The class of cases referred to are the disabilities following many injuries to joints; the fractures, which involve the surrounding muscles, tendons, etc., either in the original injury or by the protracted process of healing, and result in adhesions, contractions and deformities which are consequent upon the unnecessary and long fixation. Frequently, the results of unnecessary fixation are more severe and more permanent than from the injury itself, and necessitate a long convalescence and invalidism, during which interval the initiative disappears and mental inertia develops. The danger of this has been very well recognized for many years in civil practice, particularly dealing with cases of industrial accident surgery, in which men, taken suddenly from work, have, by the long convalescence, lost their industrial grip. The danger of the development of this mental inertia in the case of the injured soldier,—taken from his life of extreme activity and excitement, removed, as he has been, by a distinct period of time from his industrial life,—is still greater than among those removed from the ordinary conditions of civil life, when the incentives to return to industrial life are greater, because the association is less remote.

A very important feature, then, in addition to the prevention of

suffering to the patients, is this preservation of human energy by an avoidance of long periods of protracted convalescence, which energy would be lost except for this early prevention. This fact alone, brings this feature of the treatment of the soldier into prominence, as one of the most important, and places it in the front rank of general preventive medicine. During this period, the joints are given early mobilization, the fractures are given early motion, massage, etc., preventing the exudate (entirely free from a pathological character) from organizing into the strong adhesions which occasion and often make permanent the resulting deformities. By the application of this same care, and at the same time the attention to the preservation of the normal positions and relations, the preventable deformities which would require a separate treatment, often operative, to a large measure are avoided, and those which do occur are much lessened in severity.

By the early attention to this principle of treatment, the resulting disabilities, seen as deformities, contractions and adhesions, and the resulting atrophies, are reduced to a minimum, and the residue is slight in comparison. It must be recognized, however, that there will always be a residue, which will require treatment, often for long periods of time.

During the period when this treatment has been used in this war, opportunity has been given to emphasize another application of the mechanical principles of treatment, which is distinctly important in its bearing upon the industrial problem.

The employment of mechanical principles in the treatment of the reduction of deformities with their accompanying condition of contraction, adhesions and atrophies, has been in popular use for many years, and its efficiency has been proved by these many years of use. In the early periods, many special mechanical appliances adapted for specific movements have been developed, the most elaborate of which are seen in a series of Zander machines, which have had extensive use, both in their original and costly form, and also in modified and less expensive types. Undoubtedly, under many civil conditions, these will always be necessary, but under the present conditions of this war, and with disabilities which have developed from injuries in combat, a new principle in this mechanical treatment should now be emphasized. This is of added importance, since the same principles can be applied to the conditions of civil accident surgery which will arise in industrial life. The use of purely mechanical appliances is limited to the accomplishment of the local therapeutic result on each

patient; and it also carries with it the danger of too great introspection on the part of the patient toward his own particular malady. Many times, under civil conditions, the use of purely mechanical appliances will be necessary, but it is distinctly to be avoided under the conditions in which we are now working as a result of the war.

As far as is possible, it is essential to stimulate the initiative in the patient by insisting that all effort, at least after the stage in which convalescence is well under way, should be industrially productive in its results, in addition to, and independently of, the local therapeutic object. We now have this exceptional opportunity under war conditions to substitute for this unproductive mechanical therapeutic means a mechanical method of producing the same therapeutic result, but combined with an actual industrial product. Therefore, the mechanical-therapy has now the opportunity of assuming a two-fold importance: (1) That of giving the local physical benefit for which it is definitely applied, and (2) by the use of general vocational measures of combating the inertia which comes during a convalescence associated with pain; and of stimulating the individual toward developing an instinct for industry. This is not difficult, but it is essential to have special equipment, trained instructors and a definite plan of operation. To provide the equipment for this, it is necessary only to adapt the ordinary and simple occupations which are available in any simple workshop by a modification or by an adjustment of the ordinary tools or machinery so that they may be used by the men presenting deformities and disabilities, and thus obtain the same therapeutic result as when the mechanical devices are used.

To illustrate this, a contracted hand in which it is desired to increase flexibility in flexion, as well as to develop the weakened muscles controlling these motions, may be given the ordinary tools in a carpenter shop, provided these are supplied with such adjustments as to enable it to use these simple tools with its disability. The ordinary tools or the ordinary machinery are quite inadequate, even impossible, for use, since each individual will present some form of disability which will prevent his use of the ordinary tool. His very abnormality excludes his use of ordinary tools. If, on the other hand, these are provided with special handles so that the contracted hand can have a firm grasp, and they be of such shape and size that the attempt to firmly hold the appliance results in an increase of flexion, then not only can the individual use this tool as an exercise toward increasing the motion and flexibility of the part affected, but his work can also be yielding some distinct industrial

product. Also, to illustrate, a patient with contracted knee, in which it is desired to increase the motion either in flexion or extension, or both, can be given, under the old methods of treatment, one of the stationary bicycles on which he can use the motion of the wheel as an exercise for this particular object. On the other hand, with the industrial end in view, the same individual may be given some form of machine requiring a treadle motion for power, and this treadle so fitted with adjustments that the requisite amount of motion can be used and regulated. Then the exercise may be used to produce a distinct industrial result, and the individual has the satisfaction of not only working for the benefit of his own disability, but of producing something which has a distinct economic value.

The equipment of such remedial and industrial shops should not be elaborate, for the reason that only the simple, easily applied, or easily learned occupations are of value, since they will invariably be only temporary and the industrial result but a by-product, yet one of a very distinct value. The standard of excellence of this product must be maintained in spite of the fact that it is a secondary object in the treatment.

Before the war, this method had not been developed, since it had been employed, with as definite and thoroughly worked out plan for universal use, only by comparatively few, and mainly by those surgeons who were especially occupied in the so-called industrial surgery. The necessity is clearly seen of preserving the man's industrial instincts and his physical restoration at the same time, or, in other words, the man's industrial instincts must not be atrophied by the treatment or his physical restoration. During this war, this vocational principle has had a wide recognition in many forms; mainly in its application to those disabled soldiers for whom it was necessary to provide some new form of occupation. The stimulus was given early in the convalescent period by introducing some form of vocation as an occupational therapy, to combat the inertia which invariably develops in a prolonged convalescence.

In many of the hospitals in England, one may see this principle carried out in some of its details. The men there, even during the period of their hospital convalescence, work in the shops which are connected with the medical institutions and derive their physical benefit, while, at the same time, they begin some industrial pursuit which later may be of value to them. The emergencies of the war have not allowed the development of this vocational principle of treatment in its more elaborate or important details, but the practical abil-

ity of its application has been very definitely approved by the several years of its trial. The shops are all fitted for various kinds of simple occupations, each one of which demands the particular use of either contracted or weakened members or stiffened joints. The very effort to produce some distinct mechanical product stimulates the individual to increased effort, and at the same time enables him to gain strength and flexibility in the disabled member.

The effect of a distinct occupation on these men, who are necessarily detained in medical institutions for protracted periods, sometimes for many months, is seen in the eagerness and in the quickness with which they take up their occupation after their discharge, and there are many testimonials which have been given voluntarily by the men after their return to civil life which demonstrate their recognition of the value of the time spent in this work.

The same evidence of this value is found in many of the schools in France, in which the men are received after they have been discharged from the army, and to which they were allowed to go for the distinct purpose of learning some gainful occupation. The work in such schools emphasized a somewhat different phase of this principle, in that the therapeutic object is secondary, since these men primarily go to these schools with the object of learning a trade which is possible with their disability. Here very considerable attention is paid to adapt the man's tools and the machinery to his disability. But the effort which is necessary to carry on this occupation results in the gradual improvement of the distorted members and the gradual increase in strength in the atrophied or the partly paralyzed limb. The value of this work is also seen in the general attitude of these men while at work. The depressing effect of their disability, whether it be that of the loss of a limb or the distortion or paralysis of a member, does not seem to act as a deterrent on the ambition or on the persistency of these individuals. The assurance of occupation when their course of training is terminated brings an eagerness to learn and gives an air of hopefulness to these institutions which is always most encouraging.

The work which is found in the different centers in those countries which have attempted this work during their period of war demonstrates its value even under difficult circumstances, but it indicates its intrinsic value under all conditions under which it may be thus applied. If this principle of occupational therapy, then, may be adapted to this combined purpose, under the ideal conditions, the results may be expected to be correspondingly satisfactory. Such an

ideal arrangement should eliminate the purely unproductive mechanico-therapy appliances from the treatment of these disabilities resulting from injuries received under the condition when the problem of the industrial life of the individual is important. These disabilities should include the injuries both of war and of industrial accidents, two conditions which, having so much in common because of their industrial therapeutic features, should always be considered together. This elimination of the unproductive mechanico-therapy should apply at least to that part of the up and down period of the man's convalescence when he is able to be out of the ward for a distinct portion of each day, and this practically includes all of these periods of his convalescence when mechanico-therapy should naturally be used.

It becomes our duty, therefore, with our comparatively slight crippling effects of the war, and with the endless resources on which we have to draw, to establish this ideal method of treatment for these men as early in their convalescence as it is medically or surgically possible, and all that may be developed during this emergency can be handed as a legacy for the industrially crippled after the war. Naturally, to have this carried out in an ideal manner, it will be necessary to have a distinct amount of special appliances and tools and adjustments so that all kinds of disabilities can thus be treated with a minimum amount of time and effort. It is very questionable whether it is wise to begin in the earliest stages of convalescence with any of the so-called occupational therapies with any distinct ulterior motive toward individual occupation, at least to the knowledge of the patient, although a director of such occupation may have it in his own plan.

The injuries of this war group themselves into more or less distinct types of deformities and disabilities, so that the routine appliances or adjustments which are necessary in any of the so-called occupational shops are not necessarily large and never need to be elaborate or complicated. In the main, these disabilities for which the routine appliances must be provided may be grouped into those of the six main mobile regions—hand, elbow, shoulder, ankle, knee, and hip. These groups present so large a percentage of the deformities and disabilities that it is possible to have stock sets of appliances for their treatment. The other less common and more complicated disabilities must have the special adjustments devised for their individual needs. The very large number of simple occupations which have been demonstrated as practical allow a sufficiently wide scope for the employment of this principle.

Editorial

THE JOURNAL OF ORTHOPÆDIC SURGERY.

With the present issue, this Journal, which has heretofore been called the American Journal of Orthopedic Surgery, assumes its new name of the Journal of Orthopædic Surgery. That it cannot at the same time assume its additional function of representing the British Orthopædic Association through some contribution from the members of that body is a matter of deep regret. Unfortunately, and for some reason not as yet ascertained, the papers which had confidently been expected for this number of the Journal had not arrived in America at the time the Journal went to press, so that the January number, the first in which the Journal becomes the official organ of both the American Orthopedic Association and the British Orthopædic Association, cannot claim the international character which its Editorial Committee had planned.

With the elimination of the national adjective from its title, the Journal hopes to be not less American, not more British, but to invite to its columns, as always, the best of both nations.

At the present time it is the only journal in the English language dealing exclusively with orthopædic surgery. By this we mean not merely the past conception of the term in its literal sense of "straightening out the child," nor even the later pre-war connotation which it was coming to have in the minds of its broadest exponents, but we have added to this all that the orthopædic surgeon has been called upon to do by the exigencies of war and reconstruction for the straightening out of the grown man. This, as Lieut.-Col. Osgood points out, would also include some phases of industrial surgery.

Last month, in this Journal, Major Ridlon told of the difficulties in founding a journal devoted to the specialty of orthopædic surgery. It was, in the beginning, a very narrow field and the outlook precarious, but the Journal has gone on, and the specialty has gone on, until we see its culmination in the magnificent work done for our soldiers under the guidance of Sir Robert Jones.

It is this broadest and most idealistic conception of orthopædic surgery which the present Journal hopes to be the instrument for carrying on.

Correspondence

November 18, 1918.

To the Editor, American Journal Orthopedic Surgery,
Boston, Mass.

Traction, Stretching, Suspension as a Remedial Measure. Why is this so little used by medical men? Request for information by J. Madison Taylor, M.D., 1504 Pine St., Philadelphia, Pa., Prof. Applied Therapeutics, Med. Dept., Temple University.

Traction in one form or other has been employed with confidence by surgeons in the more obvious conditions involving contraction. It has been applied by physicians in a number of conditions where it seemed promising, and then abandoned. The question arises: Was it applied to suitable conditions and in judicious fashion?

In reconstruction work among war cripples traction has proven of decided advantage, especially when combined with muscle training. I am of the opinion traction could be made more efficacious where the element of muscle spasm was given more careful attention and preliminary relief afforded by manipulative moulding, mobilizing and by meeting other indications.

Traction oftentimes affords relief to discomforts even where the morphologic changes appear so slight as to be negligible.

For several years suspension was employed with much hopefulness in certain diseases of the spinal cord. At the Phila. Orthopedic Hospital and Infirmary for Nervous Diseases (where I was Chief of Clinic for Dr. Weir Mitchell) we used suspension for years. Why it was abandoned I never could learn. Some cases markedly improved; our technique was perhaps faulty. The process involved some labor and skill. The work devolved on me chiefly, and it certainly occupied much time and strength. The assistants shirked the job, and lay attendants were too few and incapable. None of these were good reasons, however, for abandoning it.

In the literature there are occasional references to traction, and by some it is highly extolled.

I should be grateful for information on the subject, and the opinion of those who have had experience or have formed definite conclusions.

Book Review

The Human Skeleton. (An Interpretation.) Herbert Eugene Walter, Associate Professor of Biology, Brown University. The Macmillan Co., New York City, 1918.

Those orthopædic surgeons who have time to pause from their routine work will be amused and instructed by a careful perusal of this work.

At first glance of the title, the average orthopædic surgeon would dismiss the book with the thought that there was very little new for him to learn regarding the human skeleton. Professor Waltér, however, has brought into association and juxtaposition a large number of anatomic facts, both morphological and comparative, and has made up of this ordinarily uninviting material a book which is really absorbing in its interest.

A great deal of the information contained is, of course, elementary. Even this it will not harm the average orthopædic surgeon to read once again. The book is full of philosophical observations which enliven the pages and contains a few puns which rather detract from the otherwise high standard of literary excellence maintained.

The following introduction to the chapter entitled "The Adaptation of the Human Foot," indicates the general tenor of the work. "Human feet have never quite recovered from their surprise at finding the body tipped up on an end and in having thrust upon them the entire responsibility of its support. They have done the best they could in the evolutionary time they have had with the inherited materials that were on hand, but it must nevertheless be confessed that the result is as yet only a makeshift foot. The various foot troubles of man are an eloquent confirmation of this statement."

Many similar doses of "food for thought" for the orthopædic surgeon are contained in these two hundred and fourteen pages. The book is evidently written primarily for the laity. The profession will also do well to read it.

Since we are reasonably assured of peace and the entrance of American armies into the conflict has made us participate more than has been our custom in international affairs, it does not seem amiss that in other affairs than military ones we should expand as internationalists. The American Orthopedic Association, therefore, welcomes the entrance upon a phase of this sort of scientific coöperation with our British ally with much satisfaction and looks forward to an expansion of our mutual scientific interests as well as to other sorts of satisfaction in the new relations. The American Editors regret that this, the first number of the journal which marks the publication of the Journal of Orthopædic Surgery, should not contain articles from our British confreres, but delay in the arrival of the manuscripts has prevented their appearance before the February edition.

Current Orthopaedic Literature

Numerals at head of each abstract are for use in connection with the official "Classification of Orthopædic Literature," published in the JOURNAL for January, 1917, reprints of which are obtainable from the JOURNAL office.

I. ORTHOPÆDIC SURGERY.

I and III, 7.

THE CASUALTIES OF WAR AND INDUSTRY AND THEIR RELATION TO ORTHOPÆDIC SURGERY. A. H. Freiberg. *Journal A. M. A.*, August 10, 1918, p. 417

This address expresses beautifully the fact that the orthopædic surgeon is being called on more and more in war work because of his superior mechanical skill together with the mastery of operative surgery.

He designs his apparatus not so much with regard to beauty as to simplicity and to the principles of surgical pathology.

Sir Robert Jones says: "The orthopædic mind thinks in terms of function."

Dr. Freiberg believes that one is an orthopædic surgeon "not in order to fit the task to an aptitude which is restricted, but rather to apply a larger vision to the solution of difficulties in a sphere which is narrowed for the sake of greater efficiency, and not for any other reason."

The work of caring for cripples in war and peace is the same, and the lesson learned in war should be utilized in time of peace.—*E. S. Hatch, New Orleans.*

III. ORTHOPÆDIC OPERATIVE, POST OPERATIVE AND ADJUVANT TECHNIC.

III, 3.

PART PLAYED BY BONE GRAFT. M. Mamourian. *British Medical Journal*, July 27, 1918.

The author believes that bone-graft surgery is not practised as widely as it should be. He summarizes the views of the pioneers in bone-graft surgery. He believes the best results are obtained when all the elements which enter into the constitution of bone are used in the graft. He says that the graft supplies the biochemical stimulus or irritant which has been abolished by trauma or disease. The new bone is formed from the diaphyseal ends, from periosteal and bony remains in the shaft and in the young by epiphyseal lengthening. Histories of four cases and diagrams accompany the article.—*Edward Z. Holt, Atlantic City.*

III, 7 and 12.

THE TRANSPORT SPLINTS OF THE AMERICAN ARMY. R. B. Osgood. *Journal A. M. A.*, August 31, 1918, p. 734.

These splints are the seven types that were advised by the Splint Board appointed by the Chief Surgeon, American Expeditionary Force, and which were later described in a manual published and distributed to the American Overseas Force. They are:

I-A. Thomas traction leg splint.

I-B. Blake-Keller hinged leg half ring and modification of Thomas traction leg splint.

II-A. Thomas traction arm splint.

B. Murray's modification of the Thomas arm splint.

III. Jones' humerus traction splint.

IV. Long Liston splint with bridge interruption.

V. Cabot posterior wire splint.

VI. Jones' "cock up" or "crab" wrist splint.

VII. Ladder splint.

Illustrations of all these splints are shown, and the various injuries for which each splint is best adapted are given.—*E. H. Hatch, New Orleans.*

III, 7 and 12, and XIX, 2.

RELATIVE VALUES OF THE PRINCIPLES OF EXTENSION, SUSPENSION AND MOBILITY EXEMPLIFIED IN BOTH CIVIL AND WAR PRACTICE BY THE HODGEN WIRE CRADLE EXTENSION SUSPENSION SPLINT. Frank G. Nifong. *Journal A. M. A.*, September 21, 1918, p. 956.

The author feels that in the treatment of fractures of long bones,—for example, the femur,—that fixation and extension, which implies counter extension, are best utilized by the Hodgen splint. Abduction and adduction can be secured and wounds in the soft parts can be completely washed and dressed. *E. S. Hatch, New Orleans.*

III, 2.

RECENT STUDIES IN THE ANATOMY AND PHYSIOLOGY OF TENDONS. THEIR APPLICATION TO THE TECHNIC OF TENDON OPERATIONS. Leo Mayer, M.D., *Journal A.M.A.*, October 12, 1918, p. 1198.

From experiments upon the animals and the cadaver Dr. Mayer points out that tendons are separated from the surrounding tissues where sheaths do not exist by a highly elastic tissue which he calls the paratenon. Various substances were employed to render tendons freely mobile in the surrounding tissues, but without success.

To preserve the mobility in the tendon transplantations of paralytics, he advocates following Biesalski's method, which utilizes the sheath of the paralyzed muscle as a physiological pathway for the transplanted tendon.

Dr. Mayer warns against overstretching of the tendon.—*Harold A. Pingree, M.D., Portland, Maine.*

III, 3, *a*.

Spinal Bone Grafting. T E. Lambert. *The Medical Journal of Australia* June 29, 1918, V. I, No. 26.

Finding that the Hibbs operation for immobilizing spinal caries by splitting the spinous processes and uniting these fragments alternately to those above and below gives a weak splint and that the Albee operation of inserting a tibial graft into the split processes does not always take, author proposes to raise the spinous processes entire from their laminae for as many vertebrae as needed, insert the tibial graft, replace all tissues and suture in place.

He frees and retracts muscles from one side as if for a laminectomy, chisels the spine free, but does not cut interspinous ligaments. Patient is kept on side till tenderness is gone and usual nursing and medical treatment of tuberculosis is enforced.

While more severe than the operations it is planned to replace, it deserves further trial. He cites ten successful cases.—*L. P. Hoole (1st Lieut., M. C., U. S. A.), Camp Greenleaf, Chickamauga Park, Ga.*

III, 3, 4, and 7.

Bone Graft and Arthrodesis in Reconstruction Surgery. F. G. Dubose *Sur., Gynec. and Obstet.*, Sept., 1918.

There is a tediousness, or time-taking element, in reconstructive surgery greater than in ordinary operations. There is a pain habit existing as truly as the status epilepticus, and painful distortions endured over many years require a long interval of time after operative relief before the pain impulse is obliterated, which is as discouraging to the patient as it is irritating to the surgeon.

Preliminary preparation of the patient in building up resistance with vaccines, protecting with sera, elimination of intestinal toxines, alkalinizing the system, loading it with carbohydrates in the form of glucose and filling the tissues with fluid before and during prolonged operations by hypodermoclysis are of value.

Technically, the joint, bone and tendon operations are not more difficult but the successful outcome is more dependent on absolute asepis, and the chances are relatively far greater for failure following a careless or indifferent aseptic technique in this class of surgery than in any other. Infection not only spells failure, but frequently is life taking. It almost certainly deprives the patient of future opportunity for a second successful trial.

Antiseptic treatment is a preoperative measure, while aseptic technique is paramount and must be actuated by mental alertness with a regard for strict cleanliness approaching fanaticism. Wherever and whenever time permits, teeth, tonsils, accessory sinuses, and all possible sources of infection are removed prior to infection; otherwise they are attended to at the same time the other surgery is done.

Reconstruction operations are the consummation of conservative surgery. All is saved that can be used, and all is used that can be saved. Brief reports of eight cases are appended, in which the author presents very satisfactory results. The article is well illustrated.—*Leo C. Donnelly, Detroit*

III, 7.

SPLINTS FOR TRANSPORTATON. Major Kendall Emerson. *Boston Medical and Surgical Journal*, Sept. 12, 1918.

Describes various splints which will provide proper and early fixation of fractures for transportation from firing line to base hospitals. The value of splints for this purpose, he says, must be judged by: 1, Efficiency; 2, simplicity; 3, adaptability; (*a*) easy access to wounds; (*b*) facilities in transportation.

A number of splints in common use by military surgeons, which conform to the above requirements he takes up by groups as adapted to various regions of the body.

1. Hand and Forearm. Straight or coäptation splints of sheet iron or wood are easily padded and made to conform to the arm.

2. Elbow, Arm and Shoulder Joint. *a*, Thomas arm splints giving fixation and traction. Cleve-hitch about the wrist with a gauze bandage gives rapidity of application. *b*, Jones humerus traction splint used for wounds above the elbow.

1. Tarsus and Forefoot. Jones rectangular foot splint used in conjunction with Jones leg splint.

2. Foot, Ankle and Lower Leg. *a*, Posterior leg splint with coäptation splints: 1. Wooden posterior splint; 2. Cabot posterior wire splint. Should be used only with side splints, care being taken to have alignment of toes and patella and right angle position of the foot. *b*, Jones combined ankle and lower leg splint may be applied outside the clothes, bending the single posterior wire and the sheet-iron bands to fit the thigh and calf.

3. Knee and Thigh. Thomas traction leg splint is the most useful splint for wounds of the lower limb and hip-joint where injury to the soft parts is such that a bearing surface for the ring is intact. He explains application of the splint in detail.

4. Hip and Pelvis. *a*, Long Liston splint, modification of the "bed-slat." An offset of wood on angle-irons allows for dressing of wounds and avoids prominence of hip and buttocks. The adjustable foot piece allows the splint to be used on either leg. *b*, Straight "bed-slat" splint, board 4 or 5 inches wide extending from the axilla to below the sole of the foot. It should be liberally padded.

5. Spine, Cervical, Dorsal, Lumbar. Bradford frame or stretcher prepared to conform with the curves of the body.—*Capt. Dean S. Luce, M.C.*

III, 7.

MEDICAL WORK WITH THE AMERICAN EXPEDITIONARY FORCES. Lieut.-Col. Robert B. Osgood, M.C. *The Military Surgeon*, Oct., 1918.

The different professional divisions of the American Medical Expeditionary Forces are in close contact with one another and work in close harmony.

During the precombat period the division of psychiatry weeded out the mentally unfit. Also the genito urinary problem immediately needed attention. Men are actively treated for syphilis for six months and then the routine anti-syphilitic treatment kept up until apparently cured. The orthopædic division found much work to be done in combating foot strain, faulty posture, back strain and inability to stand regular military training. Military training under line officers with the supervision of orthopedic medical officers in the three months time returns 80% of these men to general

military service and returns 90% for military service. This activity extends to the entire Expeditionary Force.

MEDICAL WORK IN THE COMBAT DIVISION.

The most acute attention is focused on getting the casualties back to the Evacuation Hospitals in the best possible condition and the least possible time. Genito-urinary, psychiatric and orthopedic divisions are maintained with the combat troops.

Seven splints were accepted as standards and a manual printed showing their uses. 25,000 copies of this manual were distributed to American medical men before there were any American casualties. The record time for applying a Thomas splint with all the accessories is 2 minutes and the stretcher bearers are all supposed to better 6 minutes. The fracture cases are coming back in excellent shape and the splinting is excellent.

The division of roentgenology is working out a scheme for transmitting of x-ray plates with the injured man.

The special cases of bone and joint injury are segregated as much as possible and sent to special bone and joint hospitals. These are in the advanced, intedmediate and base zones. Amputations are sent to special hospitals and early treatment for weight bearing is begun. Early applications of artificial limbs is accomplished. The responsibility for the end results of bone and joint cases has been placed with the division of orthopædic surgery.

Curative workshops are being established in orthopædic centers and the bedside reconstruction aides with their stimulating personality are winning the disabled soldiers to vocational and important occupational work. Convalescent camps under military and medical supervision are fitting the convalescent soldiers for early return to full duty.—*Leo C. Donnelly, Detroit.*

III, 7, and XIX, 2.

SOME POINTS IN THE TREATMENT OF BONE AND JOINT WOUNDS. Lennox G. Teece. *Medical Joural of Australia.* August 3, 1918.

The compound fractures of the femur were treated almost exclusively on the Thomas bed knee splint except that for those in the upper third of the thigh a Jones' abduction frame was used. This frame holds the lower fragment well abducted and thus brings it into line with the upper fragment, which is held in that position by the action of the powerful group of abductor muscles. The abduction frame secures abduction of the lower fragment, which the Thomas splint cannot do.

The deformity most difficult to overcome is posterior displacement of the lower fragment, which is present in nearly all cases. This displacement is due partly to gravity and partly to the pull of the gastrocnemius muscle. There is only one way in which this can be overcome. The posterior support must consist of strips of flannel 10 cm. wide placed in close apposition to one another under the limb, then threaded around inner bar so they can be brought under limb double. It is essential that the strip which passes under the site of fracture be adjusted first. It should be examined and tightened daily, if necessary, to overcome the posterior bowing.

If the fracture is at the junction of middle and lower thirds of the femur, the Thomas splint should be bent so that the knee is flexed to 35°, thus relaxing the pull of the gastrocnemius. The extension is made by two extension strips tied to the bottom of the splint being tightened daily, thus gradually overcoming the shortening.

If backward bowing occurs, a condition of genu recurvatum is produced, and walking is extremely difficult. To prevent shortening of the tendo achillis, the foot is maintained at right angles to the leg by means of strips of gauze glued to the dorsum and the sole of the foot, and tied to the top horizontal bar of a foot piece.

As regards wounds of the knee joint the early treatment in France followed four main lines:

(1) Excision of wounds, irrigation of the joint, complete closure of the wound after joint is filled with two per cent. solution of formalin in glycerine, or perhaps insertion of a small drain into the subcutaneous tissues.

(2) Primary excision of joint even in presence of sepsis.

(3) Wide laying open of the joint by turning the ligamentum patellae and patella upward and flexing the knee acutely, afterward straightening the limb and replacing patella when sepsis has subsided.

(4) Drainage of the joint by means of tubes passed through from side to side.

Primary excision of the joint should unhesitatingly be condemned.

Primary excision and closing of the wound gave excellent results in some cases. Wide opening of the joint with through and through drainage often resulted in ankylosis, bony or fibrous, but usually successfully combated the sepsis.

The prognosis as to movements depends mainly on whether or not there was a fracture through any part of the articular surface. In its absence the results were very good. In its presence the outlook as to movement was poor. Ununited fracture was confined almost entirely to humerus, radius, and ulna. The persistent non-unions were treated by bone graft.—*Llewellyn H. Rockwell, 1st Lieut., M.C., U.S.A.*

III, 7, and XIX, 2.

SUSPENSION AND TREATMENT BY TRACTION, OF FRACTURES IN BASE HOSPITAL WORK. G. A. Moore. *Boston Medical and Surgical Journal*, Sept. 12, 1918.

As a result of modern warfare methods, the treatment of fractures demands new methods. There are now new conditions, such as: 1, Great lacerations of soft parts and comminution of bone; 2, frequent injury to nerves; 3, extreme virulence of infection of the majority of wounds, which necessitate prolonged treatment, wet dressings, and immobilization.

The principles which should govern treatment of such injuries require: 1, Easy access to wounded limb; 2, patient should be able to move about in bed; 3, circulation maintained and edema avoided; 4, mobility of joints maintained, to prevent ankylosis; 5, apparatus adaptable to any fracture with sufficient traction.

The earliest mention of a suspension method is by Dr. Smith, in 1826, which is for base hospital work, and is the overhead Balkan frame. The Balkan frame is composed of a head piece and foot piece, two or three overhead bars to extend between head and foot piece. Narrow boards three inches wide, one inch thick are used. The head and foot pieces are strapped to the head and foot of the bed. Traction is maintained by boards glued to sides of leg and drawn tightly over bar at foot of splint.

The jointed Hodgen splint and the Balkan are both excellent.

In treatment of femur fractures at any level, flexion of hip and knee should be maintained whenever possible. Use bands of heavy cloth six to 10 inches wide for suspension. Verify with x-ray. In suspending leg fractures, pull at an oblique angle toward foot. Raise foot of bed six to ten inches.

For traction there are four methods: 1, Adhesive bands, or flannelette glued to skin; 2, Hennequin's band; 3, some form of laced gaiter; 4, direct traction by Steinman pin. Support toe to prevent toe drop.

SPECIAL FRACTURES.

First. Femur, upper third fragment, held abducted, flexed and rotated outward, lower third fragment brought into alignment with upper. To do this, flex knee or raise leg and suspend in this position with abduction. Traction made above knee, and jointed. Hodgen splint applied to prevent ankylosis of knee.

Second. Femur middle third, like upper, use slightly bent splint.

Third. Lower third, difficult to treat, due to backward pull of distal fragment, by gastrocnemius. Use Hennequin band or Steinman pin. Thomas knee splint may be used in other cases.

Fourth. Lower leg, fibula alone, not much attention. Tibia alone, suspension and traction, pull more on inner side. Both bones, traction in axis of shaft of tibia. Use lateral glued bands and avoid pressure on malleoli.

Fifth. Tarsals and metatarsals, use suspension only, no traction.

Sixth. Humerus. Use aeroplane splint, of Leyva, for suspension traction. Infected, use Balkan frame, but no splint. Use band, the width of which corresponds to length of upper arm.

Seventh. Forearm. Suspend vertically, with elbow at right angles. Bands are glued to flexor and extensor surface of the arm.

Eight. Fractures involving elbow joint are treated by Flint with splint similar to that used by Smith for leg splint.

Conclusions. Suspension and traction in the treatment of fractures was introduced because of the bad compound fractures. It is of inestimable value. Patient has more comfort, mobility of joints permitted, easy access for dressing, edema prevented, circulation better, wound heals quickly.—*N. J. Seybold, 1st. Lieut. M.C., U. S. Army.*

III, 7, *b*.

PROBLEMS OF RECONSTRUCTION OF HAND. A. Steindler. *Surg., Gynec. and Obstet*, Sept., 1918.

Reconstruction surgery of the hand involves the following problems: (1) The work of the muscle and tendon reconstruction; (2) reconstruction of the peripheral nerves and reëstablishment of the neuromuscular relations; (3) bone plasty, arthroplasty and autoplasty. The paper deals with the first problem. The complicated functions of the hand are subordinated to rigid mechanical and mathematical laws. The principal factors of muscle mechanics are: The volume of the muscle, the tension, the distance of contraction, and the angle of the application of force. Five charts are appended which show rotation and stabilizing componeuts, sine and cosine curve of muscle action, numerical contraction power in flexion and exten-

sion of wrist and the relative amount of muscle power in either optimum of tension or minimum of tension. Sources of error creep in which make the readings of comparative value. The mechanism of the wrist joint is well worked out, mechanically and geometrically.

Case reports of seven cases of Volkmann's contraction which were operated. The difficulties encountered attest the formidability of the procedure.

It is a scientific paper and impresses one how immensely complicated are the mechanics of the movements of the wrist and hand. It is well illustrated and has a complete bibliography.—*Leo C. Donnelly, Detroit.*

III 7, *c*, and XVIII, 1.

The Army Shoe and Mild Foot Disabilities. J. Torrance Rugh, M.D., Lieut. Col., M.C., U. S. Army. *Journal A.M.A.*, Oct. 12, 1918, p. 1215

Colonel Rugh gives a brief and very practical statement of the effect of the regular United States Army shoe upon the foot of the soldier. He lays great stress upon having the shoe long enough, one-half to three-quarters of an inch longer than the foot.

He calls to mind a fact which we all should remember, that a shoe may stretch laterally but never longitudinally.

He mentions the marked improvement of the soldier's foot in power, flexibility and general function, all due to proper shoeing. Not only his extensive experience in the army, but also his long years of practice as a civil orthopædic surgeon before the war, lend great weight to Colonel Rugh's article.—*Harold A. Pingree, M.D., Portland, Me.*

III 7, *c*, and XVIII, 1.

The Foot Problem. 1st. Lieut. Tom S. Mebane, M.C. *Military Surgeon*, Oct., 1918.

Based on the experiences of the Camp Orthopædic Service at Camp Beauregard.

The camp orthopædic surgeon is charged with the prevention of foot trouble, the elimination of the unfit, and the rehabilitation of men with remediable foot conditions. The first is accomplished by educational means, the second, by examinations; and the third, by the establishment of the orthopædic camp.

Methods designed to prevent foot trouble are as logical and as fruitful as methods designed to prevent infectious disease. The only excuse for foot trouble in a soldier previously fit is foot trauma. Measures taken to prevent foot trouble and the exercises to strengthen the foot muscles were included in the training schedule for the division. The orthopædist should see that the men have correctly fitted shoes.

None of the following classes of foot defects are fit for active overseas service: (1) Flaccid feet with marked abduction or eversion; (2) rigid or spastic flat feet; (3) rigid arthritic or post traumatic flat feet; (4) marked cavus; (5) pes varus or valgus following fracture; (6) extreme hallux valgus associated with painful bunion or metatarsalgia; (7) hallux rigidus; (8) amputation, or partial amputation or severe derangement of joints of the great toe; (9) proved exostoses of the undersurface of the os calcis.

The following type of cases can be accepted with the assurance that they can be made fit within a short time, in the great majority of cases: (1) Flaccid feet without much abduction or eversion; (2) ankle valgus, not the result of fracture; (3) poorly developed but not pathological feet The third great class of cases, such as hallux valgus, uninflamed bunion, claw toes, hammer toes, ingrown nails, corns or callosities, etc., can be accepted with rare exceptions. These cases, if given properly fitted shoes and such minor chiropody as may be indicated, will develop no further trouble

Forty per cent. of negroes examined had flat feet.

For overseas work a division orthopædic surgeon, company non-commissioned foot officers, regimental chiropodists and cobblers are trained.

A three weeks' course of instruction has been given to non-commissioned foot officers and regimental chiropodists.—*Leo C. Donnelly, Detroit.*

V. TUBERCULOSIS.

V, 2, *a*.

Treatment of Vertebral Tuberculosis by Fusion Operation. Report of Two Hundred and Ten Cases. Russell A. Hibbs, M.D. *The Journal of the A.M.A.*, Oct. 26, 1918, p. 1372.

Dr. Hibbs, in his paper, has described an operation containing some further extensions and improvements upon his original one. The main points are as follows: There is but one incision in midline, and the periosteum and overlying tissues are pushed aside. At least two vertebrae on each side of the lesion must be included in the operation. The periosteum must be separated from the vertebrae from the tips of the spinous processes to the articulations. The articulations are destroyed with a curette. The laminae are connected by means of long bone chips removed from their substances. The processes are broken at the bases and bent down so that each bare tip touches bare bone on the next below. It is absolutely necessary that all soft tissue be removed and that the contact between bony surfaces be perfect.

Following the bone work the periosteum is sewed over the spine as a whole and forms in this way a sort of roof over the spinous processes. A brace or corset should be worn for six months.

Dr. Hibbs reports a series of two hundred and ten cases running through a period of four years, the last one in 1915.

The cases are very methodically and carefully taken up in regard to general health, local conditions and complications, and the results are conscientiously measured. Seventy-five per cent. have been cured and twenty-five per cent. have attained varying degrees of improvement. Dr. Hibbs acknowledges his failures as well as claims his successes.

As in most surgical procedures where technic is highly developed, descriptions cannot compare with actual observations in the operating room —*Harold A. Pingree, M.D., Portland, Me.*

IX. CONGENITAL DISLOCATIONS AND LUXATIONS.

IX, 2.

Congenital Dislocation of the Hip in Three Generations. Samuel A. Jahss. *New York Medical Journal*, September 28, 1918.

This case is reported on account of its rarity, although the condition is known to be occasionally hereditary. A young girl reported for treatment

of a limp, and it was noticed that the mother showed a similar gait. The history revealed that the limp had been noticeable in both mother and daughter since walking was first begun. X-rays revealed typical congenital dislocation of the right hip. The mother stated that her mother had a limp exactly similar to that of her daughter and herself. The grandmother is dead, but her history seems to warrant the diagnosis of congenital dislocation.

XII. CHRONIC INFECTIONS OF JOINTS AND BURSAE (NON-TRAUMATIC).

XII, 1.

Isolated Disease of the Scaphoid. Charles R. McClure, M.D., *The Journal of the A.M.A.*, Oct. 26, 1918, p. 1360.

Dr. McClure reports a case of isolated disease of the scaphoid bone in a boy of 7 years. Syphilitic and tuberculous tests were negative. General health was excellent. There was no history of serious injury.

The treatment carried out by Dr. McClure was immobilization in plaster-of-Paris and prevention of weight-bearing for five months. At this time use of the foot was allowed and since then no trouble has been reported.

Four excellent skiagrams illustrate the paper.—*Harold A. Pingree, M.D. Portland, Me.*

XII. CHRONIC INFECTIONS OF JOINTS AND BURSAE (NON-TRAUMATIC).

XII, 3.

The Teeth and Tonsils as Factors in Arthritis. Roland Hammond. *American Journal of Medical Sciences,* October, 1918.

The relation of the teeth and tonsils to arthritis is at present a moot question. It is probable that the pendulum has swung too far in the direction of the wholesale removal of teeth and tonsils. There is undoubted improvement in numerous cases of arthritis following the removal of an abscessed tooth or a diseased tonsil or when a case of active pyorrhea has received proper treatment. Many such cases are, on the other hand, given similar careful treatment without affecting the progress of the joint condition in the slightest degree. Success in treatment of foci in the teeth and tonsils lies with the men who can distinguish the apical abscess and the diseased tonsil which are overcoming their infection by nature's methods. They must know by careful and special training when a tooth or a tonsil is an active agent of infection. Such knowledge must be supplemented by accurate interpretation of dental roentgenograms and skilful laboratory work. Often the focus of infection lies not in the teeth or the tonsils, but in some other part of the body, where it may be discovered by careful search. Many of the cases of chronic progressive arthritis are believed by thoughtful physicians to be due to a disturbance of the metabolism, probably chemical in nature, which produces joint changes not always to be distinguished from those caused by bacterial agency. One very suggestive fact brought out by the author's investigation has been the marked improvement

in the general health of the patients when diseased conditions of the teeth and tonsils have been properly treated. It oftentimes seems as if a millstone had been removed from their necks. This is noted very commonly even when no change was apparent in the joint condition.

XII, 11.

Case of Hemophilia with Effusion into Knee Joints. P. B. Roth. *British Journal of Children's Diseases,* April-June, 1918.

A case of hemophilia with absence of family history. The father was not a bleeder. From the x-ray diagnosis the author predicted more or less ankylosis. He advised the use of knee cages to prevent further injury, and thymus gland and calcium and magnesium salts internally. Patient's tonsils are large, red and obstructive. The author is "searching" for a surgeon to remove them.—*Edward Z. Holt, Atlantic City.*

XIII. ACUTE AND CHRONIC AFFECTIONS OF MUSCLES, TENDONS AND LIGAMENTS.

XIII, 8, *b.*

Pathology Treatment of Volkmann's Contracture. Réné Dumas. *Paris Médical,* January 26, 1918.

Insidious in the beginning, the affection is not always recognized. The typical picture of the contracture, fully developed, is as follows:

The end and middle phalanges are flexed while the metacarpo-phalangeal joint is in hyperextension; the wrist joint is flexed. In the thumb the flexion of the phalanx is not always present.

Not only active extension is impossible but also attempt at forcible correction fails, even under anesthesia. This syndrome presents not merely a complication of the fracture of the elbow but the condition is a distinct pathological entity. The term contraction, as employed by Volkmann is, according to the author, wrong and the deformity should be called a retraction. The muscle substance being involved in a process of fibrosis and having lost its normal extensibility, the author prefers the name of retractile myositis to signify infiltration sclerosis of the muscles. This sclerosis of the muscles is entirely confined to the flexor muscles of the forearm as a result of a circulatory disturbance following the injury or the application of restricting appliances. In the author's opinion, however, this explanation leaves open several questions, especially the point why this circulatory disturbance should result in sclerosis while others do not and why the sclerosis should develop exclusively in the flexor muscles.

The author distinguishes between grave anatomical lesions in which sclerosis is generalized and in the slighter lesions in which only single flexor

muscles are involved. The cause in the first group of cases is compression of the forearm by tight bandages and pressure from hematoma or phlegmon of the forearm. The author does not think the fibrous retraction alone responsible for the deformity, as by this contraction alone hyperextension in the metacarpo-phalangeal joint could not be explained, although he grants that this retraction plays an important rôle in bringing about the claw hand deformity. The determining factor of the claw hand deformity in Volkmann's contracture is the lesion of the median and ulnar nerve, in which opinion the author is substantiated by Hildebrand, Kirmisson and others. The author's definition of the deformity is as follows:

Deep contusion of the masses of the forearm muscles, accompanied by hematoma and compression of the nerve of the forearm.

In regard to the treatment of this deformity the author follows well developed lines, either plastic lengthening of the flexor tendon or shortening the bones of the forearm. He does not mention, however, the neurolysis or any operation of the peripheral nerve itself, at the stage of already developed deformity.

In a number of cases the development of this deformity can be obviated by energetic action. In the first place the cause of the compression, such as tight plaster casts, must be removed without delay, the hematoma incised, fragments removed and the compressed nerve freed. In order to avoid threatening contracture, massage and passive motion should be carried out. Passive motion toward hyperextension of the wrist and toward extension of the finger joint is of greatest importance. The prognosis of the affliction is, in the author's opinion, favorable, as the majority of cases are amenable to complete cure and Volkmann's is one of the most easily cured.

Most other observers, however, show decided reserve in predicting the restoration of the function of hands afflicted with Volkmann's contracture.—*A. Steindler, Iowa City, Iowa.*

XIV. PARALYTIC CONDITIONS.

XIV, 1, *c*.

Operation for the Correction and Prevention of Paralytic Genu Recurvatum. Willis C. Campbell. *Journal A. M. A.*, September 21, 1918, p. 967.

In this operation the tendon above the patella is lengthened, and the lower third of the patella is fixed to the anterior aspect of the tibia below the knee joint. The upper two-thirds of the patella act as a stop joint and prevent hyperextension. One case is reported.—*E. S. Hatch, New Orleans.*

XIV, 2, *c*.

An Operation for Stabilizing the Foot and Ankle in Poliomyelitis: A Further Report. Frank E. Peckham. *Journal A. M. A.*, August 10, 1918, p. 438.

The operation consists in a fascia lata transplant into the fascia of the paralyzed tendons of the foot. A good anchorage is secured, and function greatly improved.—*E. S. Hatch, M.D., New Orleans.*

XIX. TRAUMATIC CONDITIONS.

XIX, 2, *a*.

Fracture of the Spinal Column with and without Cord Injury. Norman Sharpe, M.D. *The Journal of the A.M.A.*, Oct. 26, 1918, p. 1362.

Dr. Sharpe says we think of spinal fracture in terms of cord symptoms, and calls to our attention the many cases that are not diagnosed until long after the injury He thinks that bone injury to the cord seldom takes place when the articulations are unruptured.

He urges the early use of the x-ray and early operation upon those cases possessing disturbance of the cord. He quotes a number of cases in which better results might have been secured by operation soon after the injury. His method of treatment when the cord is not involved is the use of plaster-of-Paris corsets and collars, and five such cases are reported in detail.

The article is illustrated by means of skiagrams.—*Harold A. Pingree. M.D., Portland, Me.*

XIX, 2, *c*.

Method of External Fixation for Fractured Femur. E. L. Eliason. *Sur. Gynec. and Obstet.*, Oct., 1918.

A dressing in order to be efficient must (1) fix both fragments as well as the joint above and below in whatever position is desired, (2) permit proper bed care of the patient, which means his being turned or moved without danger of strain at fracture site, (3) provide dependable traction which can be maintained and the amount accurately registered at all times, (4) permit of its application with the least possible concurrent danger of displacement of fragments at the time, and lastly allow a safe transfer of the patient.

The author seems to have filled all of these requirements for fracture of the femur. A Hawley table is used, a Bradford frame, and three additions to the Hawley table: (1) An adjustable extension permitting traction in the extremely flexed plane, (2) to counteract this pull an adjustable plate applied over Poupart's ligament and the anterior superior spine, plate attached to perineal upright of the table, (3) stirrup attachments to hold the Bradford frame level when lower end of Hawley table is dropped By means of Steinman nail or Ransohoff or Syms tongs the fracture is reduced, extension being direct on the femur. Cast is applied from umbilicus to sole of injured side and to mid-thigh of uninjured side. Cast is attached to Bradford frame at four places. Patient, cast and frame are *en bloc*, and subsequent displacement is impossible. Article is well illustrated. —*Leo C. Donnelly, New York.*

Important Notice to Subscribers

Beginning January 1st, 1919, we shall establish the policy of discontinuing from our mailing list three months after notification of the expiration of the paid period, all names of those whose subscriptions are not paid in advance.

Please be sure that your name remains in its proper place in order that your files of this Journal may be complete.

Vol. I, No. 2 FEBRUARY, 1919 Old Series: Vol. xvii, No. 2

The Journal *of* Orthopædic Surgery

SPECIALISM AND GENERAL SURGERY. BRITISH ORTHOPÆDIC ASSOCIATION. PRESIDENTIAL ADDRESS.

BY E. MUIRHEAD LITTLE, F.R.C.S.,

Senior Surgeon to the Royal National Orthopædic Hospital, London.

THE occasion of the first annual meeting of the British Orthopaedic Association seems to be a fitting one for the review of some of the aspects of the past history of orthopaedic surgery in this country, and for some aspirations for its future.

When subcutaneous surgery was given to the surgical world in the fourth decade of the last century, at the very beginning of that Victorian age, which was so rich in achievement in every field of art and science, but which it is now the fashion to affect to despise, orthopaedic surgery may be said to have awakened from the post-natal torpor in which Andry left it, so that it attracted the attention of surgeons everywhere. But after a generation had passed and orthopaedics had become almost synonymous with tenotomy and the use of instruments, or at least with subcutaneous—to the exclusion of open—methods, the subject lost interest for many surgeons, and orthopaedic hospitals were not thought much of.

So far had this tendency gone that, in 1872, a long and pompous editorial in an influential medical journal declared the existence of the hospitals to be an evil and stated that "there is probably *no* general hospital in England in which cases of deformity would not be received and cured, *no* hospital surgeon who would not treat them well..... as part of the ordinary work of his daily calling" (the italics are mine).

The journal returned to the subject week after week and in a later issue referring to an orthopaedic hospital, of which the domestic affairs were unpleasantly prominent, we may read:—"Cut it down, why cumbereth it the ground? There is not, as we have said already, the shadow of a pretence for saying that it is required to meet a public want." Lest the editor's remarks should be thought to apply only

to one institution, a week later he was careful to add:—"We fear Cæsar and Pompey are very much alike and that the other orthopædic hospitals differ from their elder sister chiefly in the fact stated—that they are not Royal."

Orthopaedic specialists were not alone in incurring the censure or contempt of the orthodox press, for all special hospitals found themselves in the chilling shade cast by journalistic disfavor. Yet it was at a special hospital that Spencer Wells made ovariotomy a success, and nearly all progress in the surgery of the eye, ear and throat may be traced to specialists and special institutions.

It would be unfair to attach too great importance to the opinion of one writer, but the fact remains that, as usual, the anonymous editor did represent a considerable body of professional prejudice, for other expressions of opinion adverse to specialism could be quoted.

In 1881 when the International Medical Congress was about to meet in London, an orthopaedic surgeon of European reputation approached his friend, Sir James Paget, the President, with a request for the inclusion in the congress of a section of orthopaedic surgery. This request was not granted, on the plea that there were not, in England, enough orthopaedic surgeons of good repute to officer the section! It was not until the meeting of the congress in 1890 at Berlin, largely at the instance of our American brethren, who had in the meantime founded the vigorous American Orthopedic Association, that an orthopaedic section was admitted.

It is hardly necessary for us as orthopaedic surgeons to ask ourselves whether the medical journalist of 1872 was justified, or whether all general surgeons might have been trusted to treat deformities successfully. We know that often they failed lamentably and disastrously for the patient. Failed not from lack of intelligence or of operative skill, but lack of attention to details and want of that necessary experience which cannot fall to the lot of the majority of general surgeons. In want of this experience they were often driven to rely, as their predecessors of the eighteenth century had relied, upon mechanicians, to whom they relegated much of the most important part of treatment. I have seen a prescription written a good many years ago by a then rising surgeon on the staff of a children's hospital for a case of paralytic deformity of the leg and foot, which ran as follows: "Suitable boot and instrument." Things have not changed much since those days for, only this year one of our medical journals contained an article by the same distinguished surgeon, now of world-wide fame, solemnly describing how with the help of an instrument maker he had devised a certain appli-

ance for a case of deformity. Just such appliances have been used for years by orthopaedic surgeons for just such cases. But he, dwelling on the Olympian heights of pure but general surgery cared for none of these things.

Why was it that our specialty had thus fallen into disrepute? It was unjustly condemned, but yet I think that there was some foundation for the accusations against it, some fire behind the smoke of calumny. Orthopaedic surgery had tended to be too conservative and to adopt as its motto "*Stare super vias antiquas.*" Listerism, which had robbed the open wound of many of its terrors, was in 1872 slowly breaking down the walls of prejudice behind which the older metropolitan surgeons were entrenched, and the advantages of skill in subcutaneous surgery were less apparent than had been the case during the previous thirty years. Yet some of the older orthopaedic surgeons refused to use the weapon which one of the greatest Englishmen of his time offered to their hands. Even across the Atlantic some of the more conservative of the founders of the American Orthopedic Association protested against the radical procedures adopted by the younger men, but happily they protested in vain.

During my later years of student life I was told that orthopaedic surgery was dead, and writers such as the editor of the journal from which I have quoted had assured us a few years earlier that all specialism was dying. I can only say with King Charles the Second, that it has been "an unconscionable time a'dying;" and now nearly half a century later, it seems very much more alive than ever.

Gentlemen, I venture to express the opinion that it is not specialism, and not the specialist that is *in articulo mortis*, but the general surgeon, the all round man with no special line of his own. The scope of surgery has become so wide, its technique has become so elaborate that only a man with the powers of a Whewell could hope to be proficient all round.

The war is an awful calamity, but it has some compensatory advantages, among which may be counted the recognition of the need of trained orthopaedic surgeons for the treatment of many injuries. We owe this recognition partly to the good work done early in the course of the war by our New England friends and still more as regards this country to our Inspector of Military Orthopaedics, Major-General Sir Robert Jones. What would our editor of 1872 have said had he been told that in 1918 there would be 30,000 beds in Military Orthopaedic Hospitals under the direction of a specialist appointed by the Government?

The ground thus gained for orthopaedics in wartime will not, I trust, be lost in peace time. In the interest of the public it is desirable that

many injuries which formerly were treated by the general surgeon should henceforth be treated by the specialist, as they now are treated in Military Orthopaedic Hospitals.

It is still more important that the treatment of these injuries should be taught by orthopaedic surgeons on the staff of all our medical schools and that more attention should be devoted to such common injuries as fractures of the long bones, the treatment of which and instruction in the treatment of which, is now thought scarcely worthy of the notice of some hospital surgeons. At least one of the great general hospitals of London, having a medical school attached to it, does not admit cases of fracture to its wards. This means that the students from that school go forth to practise their profession without having had any practical experience of the treatment of fractures of the lower extremity!

Were the treatment of fractures properly taught by specialists there would be less need for extensive bone plating operations which, although they have given brilliant results in well equipped hospitals, cannot be generally adopted throughout the country, whereas the thorough and proper use of instrumental methods is applicable by every well trained general practitioner. Were fractures, dislocations and sprains properly treated as a rule, the Bone Setters would find less excuse for their existence.

This Association owes a debt of gratitude to our American colleagues, whose cordial sympathy and advice have helped us in forming this society and who have so freely placed the fruits of their experience at our disposal. Not only have they done this but they have generously enabled us to share with them an orthopaedic journal on terms most advantageous to us.

Our two nations are for the first time allied in a great war in the cause of Right and Freedom; our Associations, without formal bonds, are united by common interest and in the common cause of Science and Humanity.

To those of you who, despite the absorbing preoccupation of these times, have provided papers for this meeting, our thanks are due.

When in future years my successors in the chair have—as I am sure they will have—a plethora of theses and of subjects of discussion, I trust that they will not despise the day of small things in the infancy of the Association. May the vigourous infant whose cradle we rock today become a prosperous adult, spreading the benefits of knowledge and experience of orthopaedics throughout the profession and the community.

THE CHANGES PRODUCED IN THE GROWING BONE AFTER INJURY TO THE EPIPHYSEAL CARTILAGE PLATE.

BY S. L. HAAS, M.D., SAN FRANCISCO,
Captain, Medical Corps, U. S. Army.

[From the Pathological Laboratory and the Surgical Pathological Laboratory of Leland Stanford, Jr., Captain, Medical Corps, U. S. Army.

THE longitudinal growth of bone is maintained by changes constantly taking place in the epiphyseal cartilage plate. As long as this highly differentiated cartilage mass persists there is opportunity for further increase in length, but with its ossification there is loss of that property. As a working principle it is necessary to know the exact portion of the epiphyseal cartilage plate that is most essential to bone growth. In the previous article[1] on the subject the following facts were ascertained. The greatest growth activity is localized in the cartilage columns of the epiphyseal cartilage plate and after the destruction of this portion of the plate length growth practically terminates. The metaphyseal cartilage serves chiefly as a medium for or is the site where the newly formed cartilage is transformed into osseous tissue. For the proper functioning of the epiphyseal cartilage plate it is essential that it shall receive an adequate blood supply. It has been shown previously[2] that, if all the blood vessels entering the bone in the region of the plate are destroyed, a very marked loss of growth takes place. This loss of growth is much greater than when the nutrient artery is destroyed. Therefore if through injury or disease the vascular supply is disturbed, then a resulting loss of growth will take place. Closely associated with the blood vessels is the character of the constituents of the blood. If there is lacking some necessary chemical elements a loss of growth is likely to take place. Thus in certain diseases and in abnormalities of the endocrine system disturbances in growth frequently occur.

Trauma is the most frequent cause of disturbances in growth of bones. The effects of trauma are quite variable and seemingly inconstant. It must be remembered that an injury in the region of the epiphyseal cartilage plate may be confined entirely to the superficial tissues, to the deeper tissues containing the vascular supply to the epiphyseal cartilage plate, to the epiphyseal cartilage plate itself or may be a combined injury of more than one of these structures. Upon the severity of the destructive process to these vital growing parts depends the resulting disturbances in growth. In the following experiments a large variety

of injuries of known degree and of known positions have been made and it is hoped that from the results obtained we will be better able to anticipate what will be the clinical picture and prognosis after certain injuries.

LITERATURE ON INJURY TO EPIPHYSEAL CARTILAGE PLATE.

The literature on injury to the epiphyseal cartilage plate from the clinical side is very extensive, but from an experimental standpoint is rather limited. At this time references will be confined to the latter and particularly to those articles which have a bearing upon the subject matter of this paper.

As early as 1872 Bidder[3] performed a series of experiments upon rabbits in which he stuck needles into the region of the epiphyseal plate and also placed cotton balls between the diaphysis and the epiphysis. He found that if he injured the outer side of the epiphyseal cartilage plate, the outer side of the bone remained shorter than the inner side; while if the inner side of the epiphyseal plate was injured then the reverse condition took place. If the whole cartilage was injured then there was an even hindrance of length growth. The epiphyseal cartilage plate was found to be degenerated or entirely missing because it was substituted through a proliferation of cells or connective tissue, or through bone trabeculae, which directly connect the diaphysis and the epiphysis.

Von Helferich[4] (quoted by Jahn) extirpated the epiphyseal cartilage plate of the distal end of the ulna in rabbits from eight days to five weeks of age and got a shortening and bending. If the cartilage was totally removed there was a complete cessation of growth.

Ollier[5] (quoted by Jahn) makes the following statements:

1. Insignificant incisions into the epiphyseal cartilage plate are without influence upon length growth.
2. Marked lesions or excisions have a strong influence and cause shortening or collapse.
3. Separation of the epiphysis is without influence if it is immediately replaced in good position.
4. The full excision of the epiphyseal cartilage causes a complete cessation of growth.

Haab[6] (quoted from Jahn). Sticking pegs into the diaphysis causes stimulation of growth because of the indirect stimulation of the epiphysis. When the epiphysis is directly stimulated or so treated there is a resulting shortening.

Vogt,[7] 1877, from a series of experiments on goats and lambs in conjunction with Telke and Thiel found that the removal of the cartilage between the diaphysis and epiphysis caused a growth disturbance in the operated bone ends, that separation of the cartilage from the diaphysis with simultaneous injury to the cartilage caused length growth disturbances; while injury to the adjoining diaphyseal end caused disturbance only when there was a destruction of a large part of the diaphyseal end. In one set of experiments he inserted a layer of gold leaf at the place of separation of the diaphysis and epiphysis and got a considerable amount of disturbance. He ascribed the loss of growth in this case to be due to the hindrance of the penetration of blood vessels from diaphysis into the epiphysis.

De Paoli,[8] 1882, experimented with two to four months old rabbits in which he loosened the lower epiphysis of the tibia. He found that healing took place through an outer callus and that as long as the periosteum remained intact and connected diaphysis and epiphysis no pseudo-arthrosis took place. Microscopically he found that the outer callus is of periosteal origin. He also found the epiphyseal cartilage bounded by the diaphysis dies while the rest remains alive and proliferates.

Ghillini,[9] in 1891, made a number of experiments upon the upper epiphyseal cartilage plate of the tibia of rabbits. He inserted ivory pegs into the epiphyseal cartilage plate for a distance of one-half cm., either on the inner or outer side. He found after two months 4 mm. of shortening, after three months, 5mm.; after five months, 6.5 mm.; and after eight months, 8 mm. of shortening. One noticed a sinking in of the cartilage on the side of the peg, and displacement of the entire epiphysis. In opposition to the findings of Ollier and Trendelenburg, he found that the ivory peg disappeared. This difference he ascribes to the fact that his peg was placed in the epiphyseal cartilage while the others placed theirs in the bone substance. Microscopically he found that after 18 days the epiphyseal cartilage plate had changed and that the cartilage columns were smaller, shorter, and more irregular; while at two months some parts had disappeared, and at eight months were entirely absent; while the normal were still present.

Jahn,[10] 1892, says that simple incisions at the junction of the epiphysis and diaphysis in bones of young rabbits is without effect upon the bone growth.

Nové-Josserand,[11] in 1893, produced longitudinal cuts and stabs into the epiphyseal cartilage of growing rabbits. Histologically he found

that the cartilage reacted with a fibrillar splitting of the ground substance and atrophy of the cartilage cells. These injuries remained in a restricted place but they could spread out. In the injured place diaphyseal ossification ceases and for this reason there is the great hindrance of length growth. In the injury which simultaneously affects both epiphysis and cartilage he found new bone tissue penetrating the cartilage from the epiphysis at the place of injury and finally inserting itself into the ossification line. Through this new bone tissue, which is wedge-shaped and which penetrates the entire epiphyseal cartilage, a synostosis between epiphysis and diaphysis is formed, and acts as a strong resisting nail to hold both together, and through this length growth is strongly influenced or stopped. He states that if this nail forms quickly then growth disturbances will be considerable, while if it is formed slowly there will be little effect upon growth.

Zoppi,[12] in 1901, made a series of experiments upon rabbits from one to three months of age. He made incisions into the upper end of the tibia in the neighborhood of the knee joint. Under microscopic examination he found that these incisions passed through the epiphyseal cartilage plate in the part where the capsules of the cartilage cells were enlarged and the cells of the same showed a plain growth proliferation. They were therefore within reach of the so-called proliferating cartilage zone. In order better to study the circulatory changes he injected Berlin Blue into the aorta. He found that on the second day after operation a fibrinous exudate, some destruction of the cartilage cells on the diaphyseal side of separation (these he claims have a lessened life property), and slight changes in the periosteum. On the fourth day there was evidence of destruction of blood corpuscles, cartilage cells, and a slight proliferation in the osteoblastic layer of the periosteum to form a thin callus. At 5-6 days there was more advanced ossification of the proliferation zone and penetration of finger-like masses of cartilage from the epiphysis. On the eighth day the line of calcification became more regular and the cartilage projections decreased in size. On the 10-11 days it was almost impossible to distinguish it from the normal. Zoppi always compared the operated bone with the normal and he never found any hindrance in the growth. Zoppi concludes that after such incision healing takes place under the influence of newly formed bone and that there is no resulting disturbances even in width of the epiphyseal cartilage line or in length of the bone.

Riedinger,[13] in 1904 (reported in 1909), cut through the lower epiphysis of the ulna in 6-8 weeks old rabbits. He found that most of his cuts went through the calcification zone of the diaphysis. Some injury of the epiphyseal cartilage was produced by rubbing of the diaphysis upon the epiphysis. This injury is dangerous if ossification is greater than the new cartilage. He found the following from his preparations of 3, 6, 9, 12, 22, 28, and 80 days. Through a proliferation of cartilage, marrow and periosteal callus the effect was gradually closed and finished at 28 days. In the epiphysis there are also certain changes, as a solution of the bone and the formation of a new epiphyseal cartilage plate. In eight cases after 40 days there was a marked atrophy of the cartilage and a bone bridge between diaphysis and epiphysis took place. It is to be taken for granted that here there was an injury to the cartilage with partial destruction. Reiner took exception to Riedinger's conclusion and said that his changes were due to infection. In conclusion Riedinger says that it is not easy to make a prognosis in man in traumatic epiphyseal separation as based upon his findings, because in man length growth proceeds more slowly and the time of cessation of length growth in the process of healing is comparatively short.

Nakahara,[14] 1909, presented a paper upon the healing processes that take place following an incision through the epiphyseal cartilage plate of rabbits. He utilizes the operative material of Riedinger, a description of which was given in the last review. He cut the lower epiphysis of the ulna with a very sharp chisel transversely in 12 rabbits. He gives a detailed report of the Roentgen ray findings and of his microscopical study in a series of experiments with duration of 3, 6, 9, 12, 17, 22, 28, 40, 80, 210, and 360 days. He found that most of the incisions passed through the ossification zone. It is an important point to know the exact position of the cut, as variation in position will give variation in results. Nakahara in general found a shortening and states that his results differ from those of Zoppi because Zoppi's incision passed directly through the cartilage. He also says that Zoppi did not make any observations after 30 days, at which time there might be a shortening, still it was more apparent at a later period. Microscopically he found very early proliferation on the part of the periosteum, perichondrium, and the marrow. Also there were changes in the epiphyseal cartilage plate at first of a degenerative but later of a regenerative nature. The chief destruction was naturally found

along the path of the incision, as was the regeneration at a later period.

Meisenbach,[15] in 1910, reported the results of attempts to influence bone growth by mechanical and chemical means. By means of hypodermic needles he injected various substances into the region of the metaphysis of rabbits six weeks old. The substances injected were water, graphite pegs (through a cannula), pure iodine, pure carbolic acid, 95% alcohol, pure formalin, and 2% formalin. He reports that there were no changes following the injection of sterile water, sterile graphite pegs staphylococcus vaccine, tincture of iodine and alcohol. There were some changes after the use of sterile graphite pegs plus staphylococcus vaccine and after pure carbolic acid. In all the cases where pure formalin was injected he found the tibia enlarged at the diaphysis but somewhat shortened in total length. This shortening he cannot account for; at first microscopically he thought it was due to the destruction of the epiphyseal line but microscopically he found that the line was thickened. With a 2% formalin he found similar charges although they were not so extensive. He concludes that of all the substances used that formalin has produced the best results, on account of its antiseptic properties and its affinity for protoplasm. That it acts as an insoluble compound and therefore affects the epiphyseal line both mechanically and chemically with a distinct local rather than a systemic tendency. It causes the formation of osteogenetic tissue by influencing the zones of provisional calcification and calcified matrix and by increasing the number of osteoblasts derived from the periosteum.

I cannot agree with his conclusions and from a study of his paper I am inclined to believe that when the needle and the chemical substances reached the epiphyseal cartilage plate there was a destruction of the cartilage with early ossification of the epiphyseal cartilage plate; that the osteogenetic reaction was the natural restorative process following the destruction. If the material did not reach the plate or the amount was small then there was a slight destruction. The shortening of the bones was undoubtedly due to the destruction of a portion of the epiphyseal cartilage plate either by mechanical or chemical means. These experiments suggest rather an interesting field for further experimentation but it appears that in order to stimulate this highly developed and sensitive region one would have to rely upon chemical substances that excite cell growth rather than upon those that destroy it; and that these must be supplied through the blood stream

in order to cause no mechanical injury to the cartilage or the blood supply.

It is noticed that in the above reviews there is a lack of complete agreement of the various authors. Particularly so is this the case with Jahn and Zoppi, who state that they find no disturbance in longitudinal growth after injury to the epiphyseal cartilage plate, which is in exact contradiction to the results of the other authors who uniformly found some hindrance in growth. It was with the idea of obtaining data to help solve some of the disputed points of this important subject and obtain information that may be of clinical value and application that the following work was undertaken.

GENERAL OPERATIVE PROCEDURE.

All the experiments were performed upon young dogs or cats from six to eight weeks of age. The animals were given a general anesthetic and the operations carried out with the usual aseptic technique. The metacarpal or metatarsal bones were selected and reached through an incision on the dorsal surface of the foot. Care was exercised to preserve the tendons, nerves, and vascular supply to the part. Upon completion of the operation the wound was closed in layers, after which an adhesive plaster dressing was applied to the foot and the animal permitted to be about upon recovery from the anesthetic. The experiments have been arranged in the following grouping, in which order they will be described:

GROUP I. SIMPLE CROSS INCISION.

1. Through the epiphysis.
2. Through the epiphyseal cartilage plate.
   - *a.* Direct incision through the plate.
   - *b.* Separation in the line of cleavage.
3. Through the metaphyseal region.

GROUP II. LONGITUDINAL INCISION.

1. Longitudinal incision through the epiphyseal end of the bone.
2. Longitudinal incision through the entire length of the bone.

GROUP III. CROSS INCISION WITH ELEVATION OF THE DISTAL SEGMENT.

1. Through the epiphysis.
2. Through the epiphyseal cartilage.
3. Through the metaphysis.

GROUP IV. LONGITUDINAL INCISION WITH REMOVAL OF A LATERAL HALF.

1. Incision through the epiphyseal end to the line of cleavage with removal of one-half.

2. Longitudinal incision extending through the epiphysis with removal of one-half.
3. Longitudinal incision through the entire length of the bone with removal of one-half.

Group V. Cross Incision with Removal of the Entire Distal Segment.

1. Incision through the epiphysis.
2. Incision in the epiphyseal cartilage plate, at line of cleavage.
3. Incision through the diaphysis.

Group VI. Cross Incision with Removal of the Proximal Segment.

1. Incision through the epiphyseal cartilage plate at the line of cleavage.
2. Incision through the metaphysis or diaphysis.

Group I. Simple Cross Incisions.

1. Incision Through the Epiphysis.

Method. After exposing one of the metacarpal or metatarsal bones an incision is made through the epiphysis distal to the epiphyseal cartilage plate. The incision is then closed in the usual way.

Exp. 1. 24 Days. Dog 68-59.

Operation. Cut across the metatarsal III. of the right hind foot just distal to the epiphyseal cartilage plate without raising either segment. The animal died at the end of 24 days.

Gross Findings. There is no evidence of any abnormality on external examination. On longitudinal section the line of incision is still visible. The measurements are as follows: Metatarsal III, left, 2.55 cm.; difference, 0.05 cm.; right, 2.5 cm. Thus there is no disturbance in growth.

Exp. 2. 55 Days. Dog 87-63.

Operation. Cut across just distal to the epiphyseal cartilage plate of metatarsal IV. of the right hind foot. The animal died at the end of 55 days.

Gross Findings. There is good healing with no evident changes in the operated bone. The measurements are as follows: Metatarsal IV: left, 3.75 cm.; difference, 0.1 cm.; right, 3.65 cm. Thus there is no disturbance in growth.

Exp. 3. 79 Days. Dog 13-51.

Operation. Cut through distal to the epiphyseal cartilage plate of the metatarsal III. of the left hind foot. The animal was killed by illuminating gas at the end of 79 days.

Gross Findings. The operated bone appears thickened at the distal end, otherwise it is normal. On longitudinal section the distal fragment separated, as it was not firmly united. There is no difference between the operated and the normal bone except at the line of incision. There is very little callus present and it appears as though cartilage is growing in from the articular cartilage. The measurements are: Metatarsal IV., 5.25 cm.; metatarsal III., 5.05 cm. This gives a loss of 0.2 cm. in the operated bone.

The Roentgenogram shows the line of incision through the epiphysis with some distortion and shortening of the epiphysis itself. There is definite shortening of the operated bone.

Microscopical Findings. There is a definite line of separation in the epiphysis. The articular cartilage is normal. At the line of separation in the epiphysis there is some tendency for an ingrowing of the articular cartilage and of the cartilage of the epiphyseal cartilage plate beneath the periosteum. Along the line of separation there are areas of cartilage which appear to have their origin from the connective tissue while other pieces of cartilage appear to be forming about the trabeculae. The epiphyseal cartilage plate is of fairly normal appearance. The remainder of the bone is normal.

SUMMARY ON INCISION ACROSS THE EPIPHYSIS.

There is only a very slight, if any, disturbance in growth following such an operation on a growing bone.

TABLE I.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
1	68-59	24 days	0.05 cm.	0.2 cm.	0.25 cm.
2	87-63	55 "	0.1 cm.	1.2 cm.*	1.3 cm.*
3	13-51	79 "	0.2 cm.	2.05 cm.*	2.25 cm.*

* Estimated.

2. INCISION THROUGH THE EPIPHYSEAL CARTILAGE PLATE.

a. DIRECT INCISION.

Method. The selected bone is exposed and the epiphyseal cartilage plate made visible. Then an incision is made directly through the cartilage without separating the surrounding tissues. The fragments are held in apposition by sutures through the overlying tissues and the wound is closed in layers.

Experiment 4. 62 Days. Dog 122-76.

Operation. Cut through the epiphyseal cartilage plate of the metacarpal IV of the left fore foot. The bone measured 2.9 cm. The animal died at the end of 62 days.

Gross Findings. There is good healing. There is an irregularity in the shape of the diaphysis due to a bulging out 0.5 cm. from the epiphyseal cartilage plate. Otherwise the appearance is normal. On longitudinal section the epiphyseal cartilage plate shows a defect in its center. The marrow appears normal.

The measurements are: Metacarpal IV, left, 3.5cm.; difference, 0.55 cm.; right, 4.05 cm.

Thus there is a lost of 0.55 cm. The growth of the op. bone is .6 while that of the normal is 1.15 cm.

Microscopical Findings. The epiphyseal cartilage plate is narrower than normal and at its central part there is an entire absence of cartilage, allowing a communication between the marrow cavity of the diaphysis and epiphysis. There is nothing special to be noted in the enlargement of the diaphysis, the change in shape is most likely due to disturbances following the incision. It is possible that after the incision new bone is deposited and the epiphyseal cartilage plate advanced farther on.

Experiment 5. 65 Days. Dog 106-70.

Operation. Made an incision through the epiphyseal cartilage plate of metacarpal IV of the left fore foot. The bone measured 2.85 cm. The animal died 65 days after the operation.

Microscopical Findings. The joint cartilage appears normal. There are no external abnormalities except that the epiphysis is distorted posteriorly on the shaft. On the longitudinal section there is found to be some distortion of the epiphyseal cartilage plate. The measurements are: Metacarpal IV, left, 3.2 cm.; difference 0.5 cm. Metacarpal III 3.7 cm.

There is a loss of growth of 0.5 cm. The growth of the operated bone is 0.35 cm., while the normal growth is 0.85.

The Roentgenogram shows the shortening of the operated bone as well as the distortion of the epiphysis. (See Fig 1.)

Microscopical Findings. The articular cartilage appears normal. The marrow and trabeculae appear normal.

There is no evidence of the line of incision. The epiphyseal carti-

FIG. 1.—Experiment 5. Sixty-five days. Dog 106-70. Incision through the epiphyseal cartilage plate. Right in photograph, B, second bone from the right, 4, is the operated bone, showing the shortening when compared with its neighbor, 3, which it normally equals. Left in Photograph, A, shows the normal relation of the length of the bones (3 and 4 are equal in length).

lage plate is fairly regular but considerably narrower than the normal. There is a lack of cartilaginous buds projecting from the metaphysis into the diaphysis.

EXPERIMENT 6. 79 DAYS. DOG 14-50.

Operation. Cut through the epiphyseal cartilage plate of the metacarpal III of the right fore foot without severing from the surrounding tissue. The bone measures 2.7 cm. The animal was killed with illuminating gas at the end of 79 days.

Gross Findings. The bone is shorter and the epiphyseal end is distorted. On longitudinal section the epiphyseal cartilage plate is found to be distorted. The part beneath the dorsal surface is absent and replaced by new bone. The remainder of the plate is not so prominent as the normal. The measurements are: Metacarpal III, left, 5.05 cm.; difference, 1.25 cm.; right, 3.8 cm.

Thus there is a loss of 1.25 cm. The growth of the operated bone is 1.1 cm. while the normal growth is 2.35 cm.

Microscopical Findings. The general structure of the bone is normal. The epiphyseal cartilage plate is almost absent dorsally and is replaced in part by young osteoid tissue. The remainder of the line is not so regular and even as normal. The columns of cartilage are

short and uneven. There is not the long regular projection of ossifying cartilage buds in the metaphyseal region.

The marked loss of growth in this experiment is not wholly due to the incision. It was more than likely that with the displacement of the fragment additional injury was caused with a consequent loss of growth.

SUMMARY ON INCISION THROUGH THE EPIPHYSEAL CARTILAGE PLATE.

In each instance there is a definite disturbance in growth. Following such an incision there is a restoration of the continuity and form of the epiphyseal cartilage plate, although there is a lessening of its width. Growth does not cease but it appears that the ossification of the plate is hastened as indicated by changes in its center. The greater the injury to the epiphyseal cartilage plate the greater the disturbance in growth.

TABLE II.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
4	122-76	62 days	0.55 cm.	0.6 cm.	1.15 cm.
5	106-70	65 "	0.5 cm.	0.35 cm.	0.85 cm.
6	14.50	79 "	1.25 cm.	1.1 cm.	2.35 cm.

b. INCISION THROUGH THE PERIOSTEUM WITH SEPARATION IN THE LINE OF CLEAVAGE.

Method. An incision is made through the periosteum around the dorsal and lateral aspects of the bone, after which pressure is made upon the head of the bone. The epiphysis separates from the metaphysis uniformly in the region of the large vesicular cells of the column of the cartilage.

EXPERIMENT 7. 62 DAYS. DOG 122-76.

Operation. After exposing the epiphyseal plate of the metacarpal IV of the left fore foot an incision is made through the periosteum and separation made in the line of cleavage. The bone measured 2.9 cm. in length. The animal died at the end of 62 days.

Gross Findings. On longitudinal section the diaphysis is found to be broad and irregular near the metaphysis. There is a defect in the center of the epiphyseal cartilage plate but the remainder of the bone is normal. The measurements are as follows: Metacarpal IV, left, 3.5 cm.; difference, 0.55 cm.; right, 4.05 cm.

Thus there is a 0.55 cm. loss of growth since the operation. The normal growth is 4.05—2.9=1.15 cm.

Experiment 8. 65 Days. Dog 106-70.

Operation. The operation is the same as in the previous experiment. The metacarpal IV of the left fore foot is the selected bone and measures 2.85 cm. in length. The animal died at the end of 65 days.

Gross Findings. The bone appears normal throughout. The measurements are as follows: Metacarpal IV, left 3.70 cm. Metacarpal III, 3.20 cm. Difference is 0.5 cm.

Thus there is a loss of 0.5 cm. since the operation while the normal growth is 3.7—2.85=0.85 cm.

Experiment 9. 107 Days. Dog 24-55.

Operation. Exposed metatarsal III of the right hind foot. After making an incision through the periosteum around the epiphyseal cartilage plate a separation is made in the line of cleavage. The parts are restored without disturbing from their normal surroundings. The animal was killed by illuminating gas at the end of 107 days.

Gross Findings. There is normal healing. There is a normal appearance throughout except for a slight change in the curve of the epiphyseal cartilage plate. The measurements are as follows: Metacarpal IV, 5.5 cm. Metacarpal III, 4.85 cm. Difference, 0.65 cm.

Thus there is a loss of 0.65 cm.

Microscopical Findings. The epiphyseal cartilage plate possesses practically a normal structure aside from a hyaline-like groundwork between the cartilage columns nearer the center. A considerable portion of the vesicular layer is absent.

Table III.

Exp. No.	Dog No.	Duration	Loss of Growth	Growth of Operated	Growth of Normal
7	12-76	62 days	0.5 cm.	0.75 cm.	1.25 cm.
8	106-70	65 "	0.1 cm.	0.75 cm.	0.85 cm.
9	24-55	107 "	0.65 cm.	1.85 cm.	2.5 cm.

SUMMARY ON SEPARATION IN THE LINE OF CLEAVAGE.

Thus it is noted after such an experiment there is also a disturbance in growth perhaps as much as takes place after the incision. In one experiment, No. 8, it is noticed that there is only 0.1 cm. loss of growth, so that it is possible under ideal conditions to make a separation without causing a loss of growth. In order to attain such a result a minimal amount of destruction to the cartilage cells and the circulation must be inflicted.

It is also noticed that there is about the same amount of disturbance following an incision through cartilage as there is after a separation in the line of cleavage.

3. INCISION THROUGH THE METAPHYSEAL REGION.

Method. After the exposure of one of the bones of the foot an incision is made across the bone in the region of the metaphysis.

EXPERIMENT 10. 30 DAYS. DOG 112-72.

Operation. Cut through the metaphyseal region of the metatarsal III of the left hind foot without raising either segment. The alignment is restored and the bone held by suture in the surrounding tissue. The animal died at the end of 13 days.

Gross Findings. There is good healing. The line of incision is not visible. The measurements are: Left, 3.2 cm.; difference, 0; right, 3.2 cm. Thus there is no disturbance in growth.

EXPERIMENT 11. 24 DAYS. DOG 67-59.

Operation. Cut across just on the proximal side of the epiphyseal cartilage plate of the metatarsal IV of the right hind foot. The bone measures 2.3 cm. The animal died at the end of 24 days.

Gross Findings. There is good healing. On longitudinal section one can see the line of incision passing through the bone. The measurements are as follows: Metatarsal III, left, 2.55 cm.; difference, 0.05 cm.; right, 2.5 cm. (op). The operated bone is 0.2 cm. longer while the normal is 0.25 cm. Thus there is practically no disturbance in growth since the operation.

EXPERIMENT 12. 33 DAYS. DOG 115-73.

Operation. Cut across the metaphysis of the metatarsal III of the left hind foot without raising from its bed. The bone measures 2.9 cm. The animal died at the end of 33 days.

Gross Findings. There is good healing. A line is noticed in the region of the incision. The measurements are as follows: Metatarsal III, left, 3.1 cm.; difference, 0.1 cm.; right, 3.2 cm. There has been 0.2 cm. of growth of the operated, while the normal bone has increased 0.3 cm. Thus there is a very minimal disturbance in growth.

Experiment 13. 42 Days. Dog 109-71.

Operation. Cut through the metaphyseal region of the metatarsal IV of the left hind foot without raising. The length of the bone is 3.0 cm. The animal died at the end of 42 days.

Gross Findings. The healing is good. From external observation there is no difference between the operated and the normal. On longitudinal section there is an entirely normal appearance throughout. The measurements are as follows: Metatarsal III, left, 3.65 cm.; difference, 0.05 cm.; right, 3.7 cm. Thus there is practically no loss of growth. The operated bone has increased 0.65 cm. in length, while the normal has increased 0.7 cm.

Experiment 14. 48 Days. Dog 118-74.

Operation. Cut through the metaphysis of the metatarsal IV of the right hind foot without raising either fragment. The length is 2.85 cm. The animal died 48 days later.

Gross Findings. There is good healing. Nothing abnormal is made out of an external examination. On longitudinal section there is found to be a slight change in the tissue in the metaphyseal region. The measurements are as follows: Metatarsal IV, left, 3.65 cm.; difference, 0.05 cm.; right, 3.6 cm. The operated bone has increased 0.75 cm., and the normal bone 0.8 cm. Thus there is practically no loss of growth since the operation.

Summary of incision through the metaphysis.

A simple incision across the metaphyseal region healed as a fracture in the shaft of the bone without causing any disturbance in length growth.

Table IV.

Exp. No.	Dog No.	Loss of Growth	Growth of Operated	Growth of Normal
10	112-72	——	——	——
11	67-59	0.05 cm.	0.2 cm.	0.25 cm.
12	115-73	0.1 cm.	0.2 cm.	0.3 cm.
13	109-71	0.05 cm.	0.65 cm.	0.7 cm.
14	118-74	0.05 cm.	0.75 cm.	0.8 cm.

Comparison of injury by incision across the bone.

It was noticed that an incision across the epiphysis distal to the epiphyseal cartilage plate and an incision across the metaphysis prox-

imal to the plate is without effect upon the longitudinal growth. An incision in the epiphysis is more likely to result in a disturbance, because there is a possibility of injuring the growing part of the cartilage column if it comes too near the plate.

An incision through the epiphyseal plate always caused a considerable loss of growth because it destroyed vital cells in the region responsible for longitudinal growth, namely of the cells of the cartilage columns. A separation in the line of cleavage may be produced without causing any disturbance in growth, but as a rule even after such an operation there is resulting loss of growth.

GROUP II. LONGITUDINAL INCISIONS THROUGH THE EPIPHYSEAL CARTILAGE PLATE.

1. Longitudinal Incision Through the Distal Portion of the Bone Including the Epiphyseal Cartilage Plate.

Method. After exposing one of the bones an incision is made longitudinally from the articular cartilage through the epiphyseal cartilage plate into the diaphysis. The bone was neither removed nor the surrounding tissues disturbed.

EXPERIMENT 15. 13 DAYS. DOG 111-72.

Operation. Made an incision longitudinally through the distal one-third of the metatarsal IV of the left hind foot. The animal died at the end of 13 days.

Gross Findings. There is good healing. The line of incision is still visible. The measurements are as follows: Metatarsal IV, left 3.3 cm.; difference, 0; right 3.3 cm. Thus there is no difference in length of the operated and the normal bones.

EXPERIMENT 16. 38 DAYS. DOG 93-66.

Operation. Made an incision through the distal one-third of the metacarpal III of the left fore foot. The animal died at the end of 38 days.

Gross Findings. The appearance of the operated bone is normal. Firm union has taken place in the line of incision. The measurements are as follows: Metacarpal III, left (op.) 2.9 cm.; difference, 0.2 cm.; right, 3.1 cm. Thus there is a difference of only 0.2 cm. between the two sides.

EXPERIMENT 17. 48 DAYS. DOG 117-74.

Operation. Split longitudinally the distal one-third of the metatarsal III of the right hind foot. The bone measured 2.85 cm. The animal died at the end of 48 days.

Gross Findings. Good healing is present. The articular cartilage shows a small defect posteriorly although the remainder is healed and appears normal. There is a trace of the incision in the region of the epiphyseal cartilage plate, but the union is firm. The measurements are as follows: Metatarsal III, left, 3.55 cm.; difference, 0.1 cm.; right, 3.45 (op.) There is only 0.1 cm. difference between the operated and normal one. The operated bone has increased 3.45—2.85=0.6 cm in length, while the normal increase has been 3.55—2.85=0.7 cm.

Microscopical Findings. The path of the incision can be followed through the articular cartilage and epiphyseal cartilage plate.

The perichondrium appears to be bridging the gap but one cannot determine exactly whether the fibrous cartilage arises from it or whether it is not being formed by a process of metaplasia. There is practically no tendency to bridge the gap in the epiphyseal cartilage plate except in the ossifying layer of the epiphysis where there is some newly formed cartilage. The columns most likely agglutinated and separated during preparation, but show no proliferation of cartilage.

The defect in the articular cartilage is filled up with a fibrous mass of tissue which in places appears like young cartilage cells.

EXPERIMENT 18. 67 DAYS. DOG 104-69.

Operation. Split the metatarsal IV. of the left hind foot through one-half its length at the distal end. The bone measures 2.85 cm. The animal died in 67 days.

Gross Findings. There is good healing. The line of incision is visible in the articular cartilage. In some places it is found to be bridged over with cartilage. The measurements are: Metatarsal IV, left, 4.2 cm.; difference, 0; right 4.2 cm. Thus there is no loss of growth. The increase in length since operation is 4.2—2.85=1.35 cm.

SUMMARY ON LONGITUDINAL INCISION THROUGH THE EPIPHYSEAL CARTILAGE PLATE.

In no instance after a longitudinal incision extending through the epiphyseal cartilage and one-half of the bone has there been any hindrance of growth of the bone.

TABLE V.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
15	111-72	13 days	0	——	——
16	93-66	38 "	0.2 cm.	——	——
17	117-74	48 "	0.1 cm.	0.6 cm.	0.7 cm.
18	104-69	67 "	0	1.35 cm.	1.35 cm.

LONGITUDINAL INCISION THROUGH THE ENTIRE LENGTH OF THE BONE.

Method. An incision is made through the entire length of the bone without disturbing either segment from the surrounding tissues.

EXPERIMENT 19. 15 DAYS. DOG 71-56.

Operation. The metacarpal IV is split longitudinally in half but not disturbed from its natural bed. The bone measures 2.2 cm. The animal died at the end of 15 days.

Gross Findings. There is good healing. The two halves of the bone are firmly united. The measurements are: Metacarpal IV, left, 2.25 cm.; difference, 0; right, 2.25 cm. Thus there is no difference in length. It is also to be noted that there has been practically no increase in length since the operation.

Microscopical Findings. One sees a separation in both articular cartilages as well as in the epiphyseal cartilage plate. The splits in the articular cartilages are filled with fibrin undergoing organization. There is no evidence of proliferation of these cartilage cells bordering on the diastasis. The osseous tissue of the trabeculae is growing in slightly at one place. The operation in the epiphyseal cartilage plate is likewise filled with organizing fibrin but there is no evidence of proliferation of cartilage cells. Along the tract at places in the diaphysis are areas of osteoid and fibrous tissue.

EXPERIMENT 20. 15 DAYS. CAT 75-5.

Operation. Split the metacarpal IV of the left fore foot the entire length of the bone. The bone measures 1.55 cm. The animal died at the end of 15 days.

Gross Findings. The healing is good. The measurements are as follows: Metacarpal IV, left, 1.7 cm. (op.); difference, 0; right, 1.7 cm. Thus there is no loss of growth. The growth since operation has been but 0.15 cm.

EXPERIMENT 21. 55 DAYS. DOG 85-63.

Operation. Split the metacarpal III of the left fore foot its entire length. The bone measures 2.05 cm. The animal died at the end of 55 days.

Gross Findings. The healing is good. The measurements are as follows: Metacarpal III, left (op.), 3.15 cm.; difference, 0.25 cm.; right, 3.4 cm. There is a loss of 0.25 cm. in growth since the opera-

tion. The growth of the normal bone has been 1.35 cm., while that of the operated has been 1.1 cm.

EXPERIMENT 22. 62 DAYS. CAT 58-48.

Operation. Split the metacarpal IV of the left fore foot the entire length of the bone. The bone measures 1.9 cm. The animal died at the end of 62 days.

Gross Findings. The healing is good. There is a slight sliding of the segments with overlapping. The measurements are as follows: Metacarpal IV, left, 2.0 cm.; difference, 0.2 cm.; right, 2.2 cm. There is 0.2 cm. loss of growth. The entire growth of the operated bone is only 0.1, while the normal growth is but 0.3 cm.

EXPERIMENT 23. 109 DAYS. DOG 80-61.

Operation. The metatarsal III of the right hind foot is split longitudinally the entire length. It measures 2.7 cm. The animal was killed with chloroform at the end of 109 days.

Gross Findings. There is good healing. The articular cartilage

FIG. 2.—Experiment 23. 109 days. Dog 80-61. Splitting the bone longitudinally its entire length. The third bone from the left, 3, is the operated bone, and is shorter than its neighboring bone, 4, which it normally should equal.

has almost entirely healed over. The epiphyseal cartilage plate is almost of normal structure although it is not quite so regular as normal. The measurements are as follows: Metatarsal III, left, 5.1 cm.; difference, 0.5 cm.; right, 4.6 cm. There is a loss of 0.5 cm. in length since the operation. The operated bone has increased 1.9 cm. in length, while the normal bone has increased 2.4 cm. (See Fig. 2.)

SUMMARY ON LONGITUDINAL INCISION ON THE ENTIRE LENGTH OF THE BONE.

There is a definite disturbance in growth following such an incision. This loss cannot be ascribed to the direct injury to the epiphyseal cartilage plate, because it was shown in the last set of experiments, where the longitudinal incision passed through the plate that there was no loss of length growth. The loss here may be due to greater destruction of blood vessels. There is also more mobility of the two opposing surfaces, allowing a rubbing and destruction of cartilage cells in the epiphyseal cartilage plate.

TABLE VI.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
19	71-56	15 days	0	0.05 cm.	0.05 cm.
20	75-5	15 "	0	0.15 cm.	0.15 cm.
21	83-63	55 "	0.25 cm.	1.1 cm.	1.35 cm.
22	58-48	62 "	0.2 cm.	0.1 cm.	0.3 cm.
23	80-61	109 "	0.5 cm.	1.9 cm.	2.4 cm.

GROUP III. CROSS INCISION AND RAISING OF THE DISTAL FRAGMENT.

1. Through the Epiphysis.

Method. An incision is made across the epiphysis just distal to the epiphyseal cartilage plate. The tissues about the end of the bone including the joint capsule are severed, the segment raised and reimplanted. By suturing the surrounding tissue the segment is held in place.

EXPERIMENT 24. 9 DAYS. DOG 31-73.

Operation. Raised the epiphysis distal to the epiphyseal cartilage plate of the metatarsal IV of the right hind foot, and replaced. The entire length of the bone is 2.6 cm. The animal died at the end of 9 days.

Gross Findings. The line of union in the epiphysis is not firm. The measurements are as follows: Rt. metatarsal IV, 2.75 cm. (op.); Rt. metatarsal III, 2.7 cm. Thus there is no difference in length.

Microscopical Findings. The incision is found to pass just beyond the inner layer of the articular cartilage. The space is filled with fibrin and there is some evidence of osteoid growth about some of the trabeculae in the immediate vicinity.

EXPERIMENT 25. 22 DAYS. DOG 147-86.

Operation. Cut through just distal to the epiphyseal cartilage plate of the metatarsal IV of the right hind foot, raised and reimplanted. The bone measures 3.0 cm. The animal died at the end of 22 days.

Gross Findings. The joint capsule is thickened but does not contain an excess of synovia. The articular cartilage is smooth but wider than normal. The line of incision is not visible. The epiphyseal cartilage plate appears normal. The measurements are as follows: Metatarsal IV, left, 3.8 cm.; difference, 0.15 cm.; right, 3.65 cm. (op). Thus there is only a very slight decrease in size of the bone. The measurement of the operated bone is 3.68—3.0=0.65 cm., while the normal increase is 0.8 cm. The Roentgenogram shows the slight shortening and one can still make out the region through which the incision passes.

Microscopical Findings. The articular cartilage is thickened and appears fairly normal except that the cartilage cells show more grouping than usual. The marrow and trabeculae appear fairly normal throughout the epiphysis and one cannot distinguish the part operated upon. There is a fibrous ingrowth on both borders, showing the site of the incision. The epiphyseal cartilage plate and remainder of the bone are normal.

EXPERIMENT 26. 48 DAYS. DOG 131-79.

Operation. Removed the epiphysis distal to the epiphyseal cartilage plate of the metatarsal III of the right hind foot.

Microscopical Findings. There is good healing, but the external appearance of the bone is normal. The segment is not firmly united. On longitudinal section there is some evidence of reparative changes. The measurements are as follows: Metatarsal III, left, 3.7 cm.; difference, 0.1 cm.; right, 3.6 cm. (op.). Thus there is practically no loss of growth following this operation. The growth of the operated bone is 0.4 cm., while that of the normal bone is 0.5 cm.

EXPERIMENT 27. 55 DAYS. DOG 86-63.

Operation. Cut across the metatarsal III of the right foot just dis-

tal to the epiphyseal cartilage plate, raising and reimplanting the distal segment. The animal died at the end of 55 days.

Gross Findings. There is good healing. Nothing especially abnormal noted. The measurements are as follows: Metatarsal III, left, 3.7 cm ; difference, 0.2 cm.; right, 3.5 cm. (op.). Thus there is but 0.2 cm. loss in growth of the operated bone, which has increased about 1.0 cm. since the operation.

EXPERIMENT 28. 79 DAYS. DOG 12-51.

Operation. Cut across and raised the portion of the epiphysis distal to the epiphyseal cartilage plate of the metacarpal III of the right fore foot. The animal was killed by illuminating gas at the end of 79 days.

Gross Findings. There is good healing. The tissue about the joint capsules is thickened. The articular surface is irregular and covered with fibrous tissue. On longitudinal section the articular cartilage is uneven. The entire epiphysis is distorted and much smaller than normal. The line of incision can be partially made out. The epiphyseal cartilage plate appears normal except that it has a straighter contour than usual. The measurements are as follows: Right metacarpal IV, 4.7 cm.; right metacarpal III, 4.1 cm. There is a loss of 0.6 cm. That this loss is not due to the collapse of the epiphysis is evident from the measurement of the diaphysis of the two bones: Diaphysis of metacarpal IV, 4.0 cm.; diaphysis of metacarpal III, 3.5 cm. The Roentgenogram shows the shortening of the operated bone. There is a definite loss of growth of the diaphysis. The line of incision comes close to the epiphyseal cartilage plate and on one border might extend into it.

Microscopical Findings. There is a pannus of fibrous tissue covering the articular cartilage. The articular cartilage cells appear irregular and in places are destroyed. It appears as though some additional factor besides the simple incision is producing this condition. The line of incision can be followed across the epiphysis. It is irregular and in places comes very near the epiphyseal cartilage plate. At the line of incision there is an ingrowth of fibrous tissue and young cartilage; in fact, in places, it appears as though both edges of the wound were being lined by cartilage.

The epiphyseal cartilage plate is regular and normal at both ends but in the center there is a marked defect and the cartilage has been replaced by fibrous tissue. There was evidently an injury to the epiphyseal cartilage plate at this point and this explains the abnor-

mal loss of growth. The cancellous bone of the epiphysis is very scanty. The diaphysis appears fairly normal. This experiment emphasizes the important fact of knowing exactly where the incision passes in order to make a correct interpretation of the results.

SUMMARY ON INCISION DISTAL TO EPIPHYSEAL CARTILAGE PLATE AND RAISING DISTAL FRAGMENT.

Unless there is an accompanying injury to the epiphyseal cartilage plate there is practically no disturbance after such a procedure. The result is about the same as after a simple incision across the epiphysis.

TABLE VII.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
24	31-73	9 days	0.05 cm.	0.1 cm.	0.15 cm.
25	147-86	22 "	0.15 cm.	0.65 cm.	0.8 cm.
26	131-79	44 "	0.1 cm.	0.4 cm.	0.5 cm.
27	86-63	55 "	0.2 cm.	——	——
28	12-51	79 "	0.6 cm.	——	——

2. Through Epiphyseal Cartilage Plate and Raising of the Distal Segment.

Method. After exposing the epiphyseal cartilage plate an incision is made in the periosteum and the epiphysis is separated from the metaphysis in the line of cleavage. The entire epiphysis is then raised from its bed and reimplanted. The fragment is held in place by sutures through the overlying tissue.

EXPERIMENT 29. 9 DAYS. DOG 30-73.

Operation. Separated the epiphysis of the metatarsal III of the left hind foot and reimplanted. The bone measures 2.6 cm. The animal died at the end of 9 days.

Gross Findings. Normal healing is present. On longitudinal section the marrow of the epiphysis is of yellow color instead of the normal red. There is a whitish area at the line of union. The epiphyseal cartilage plate is swollen. The measurements are 2.85 cm. of the normal, while the operated is 2.7 cm. Thus there is a 0.15 cm. shortening even at this early period.

Microscopical Findings. The articular cartilage appears fairly normal. The marrow of the epiphysis shows early necrosis. The nuclei of the trabeculae show loss of staining, the epiphyseal cartilage plate is swollen and the nuclei, especially of the columns of the cartilage, take a poor stain and appear partially crenated. There is little evidence of healing in the line of separation which passes through

the vesicular cells of the cartilage columns. There is some fibrinous exudate. The metaphysis appears normal except for the presence of young connective tissue near the line of incision. The remainder of the bone appears normal.

Experiment 30. 28 Days. Dog 144-85.

Operation. Raised and reimplanted the epiphysis of metatarsal III of the right hind foot. The bone measures 2.45 cm. The animal died at the end of 28 days.

Gross Findings. There is considerable distortion about the epiphysis. The joint cavity is obliterated and there is a fibrous tissue covering the articular cartilage. On longitudinal section the epiphysis is found to be distorted upon the shaft. There is very little cancellous bone present. The epiphyseal cartilage plate is very irregular. One portion has a fairly normal appearance and occupies a portion nearer the end than the other. The other portion of the plate is represented by an irregular cartilage-like tissue. The remainder of the bone appears normal. The measurements are as follows: Metatarsal III, left, 3.3 cm.; difference, 0.4 cm.; right, 2.9 cm. The increase of the operated bone is 2.9—2.45=0.45 cm. since the time of operation, while the normal increase is 3.3—2.45=0.85 cm.

Microscopical Findings. The articular cartilage is quite irregular in shape and there is a fibrous tissue mass on the surface. The cellular arrangement of the articular cartilage is very irregular although the structure of the cells is good. The trabeculae for the greater part are cartilaginous. The marrow contains some normal cells. The epiphyseal cartilage plate consists of two parts, one half which is fairly normal, the other which is made up of an irregular mass of cartilage in various stages of active proliferation. It appears as though there was not a complete separation in this line of cleavage and the part that is normal most likely remained behind intact. The portion that was raised has undergone certain degenerative changes in the substance of which there is some proliferation of cartilage from the perichondrium. Beyond the metaphysis the bone is of normal structure.

Experiment 31. 51 Days. Dog 128-78.

Operation. Reimplanting the epiphysis including the epiphyseal cartilage of the metatarsal III of the right hind foot. The bone measures 3.35 cm. The animal died at the end of 51 days after the operation.

Gross Findings. There is good healing. On external examination there is found to be a small defect in the epiphyseal cartilage plate on the dorsal surface. The "plate" appears more yellow than usual. On longitudinal section there is found to be a line in the epiphysis itself, away from the "plate" as though the incision passed through that particular place. The marrow appears pale in one spot. The epiphyseal cartilage plate appears normal. The measurements are as follows: Metatarsal III, left, 4.2 cm.; difference, 0.5 cm.; right, 3.7 cm. The growth of the operated bone is 3.7—3.35=0.35 cm., while the normal growth is 4.2—3.35=0.85.

The Roentgenogram shows the shortening of the operated bone with some irregularities in the region of the epiphyseal cartilage plate and broadening of the diaphysis. It does not show the degenerative changes of the epiphyseal cartilage plate. (See Fig. 3.)

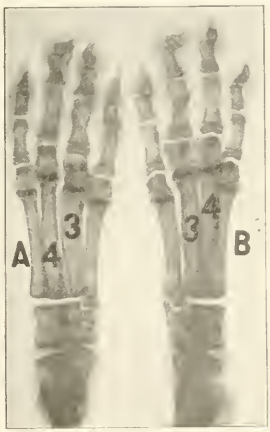


FIG. 3.—Experiment 31. Dog 128-78. Separation in the line of cleavage of the epiphyseal cartilage plate, then raising and reimplanting the epiphysis. Left in photograph, A, third bone from the left, 3, is the operated bone. Notice the shortening when compared with its fellow, 4, which it normally equals. No growth since operation. The epiphyseal cartilage plate is irregular in form.

Microscopical Findings. The articular cartilage appears fairly normal. The line that was noticed in the gross is a band of cartilage

passing across the epiphysis. The marrow of the epiphysis is for the greater part fibrous. The trabeculae for the most part show evidence of degeneration, some show regeneration on their periphery. The epiphyseal cartilage plate is fairly regular but is lacking in the character of active, proliferative appearance. The nuclei have lost a considerable part of their staining property.

The metaphysis, although having fairly normal arrangement, lacks the normal active osteogenetic changes. The cells for the greater part have light stained nuclei and there is considerable fibrous tissue between the columns. The picture is more of degeneration than regeneration. The remainder of the bone appears normal.

Experiment 32. 62 Days. Dog 123-76.

Operation. Cut through at the epiphyseal cartilage, raised, and reimplanted the epiphysis of the metatarsal III of the right hind foot. The bone measured 3.2 cm. The animal died at the end of 62 days.

Gross Findings. The joint capsule is thickened and the joint cavity contains a small amount of synovial fluid. The articular cartilage is smooth. On longitudinal section it is noticed that the entire epiphyseal end of the bone is enlarged. The marrow is mottled in appearance. The epiphyseal cartilage plate is of fairly normal structure. The remainder of the bone appears normal. The measurements are: Metatarsal III, left, 4.35 cm.; difference, 0.8 cm.; right, 3.55 cm. There is a loss of 0.8 since the operation. The operated bone has increased 0.35 cm. while the normal has increased 1.15 cm.

Microscopical Findings. The articular cartilage appears normal. The marrow of the epiphysis is for the greater part normal with a scattered area of fibrous tissue and in parts an increase in vascularity. The trabeculae have a fairly normal structure. The epiphyseal cartilage plate is degenerated near the center and in part replaced by a fibro-cartilaginous tissue. At the periphery the cartilage has a fairly normal structure. The metaphysis shows a considerable change in the middle where there is a loss of the ossifying buds, they being replaced by dense bone. There is also a marked elongation of some of the columns at the center, possibly due to a superimposition of the epiphyseal cartilage plate upon some of the columns that remained in process of separation.

Experiment 33. 79 Days. Dog 15-50.

Operation. Raised and reimplanted the epiphysis of the metatarsal

IV of the left hind foot. The animal was killed with illuminating gas at the end of 79 days.

Gross Findings. The joint capsule is thickened and the articular cartilage is rough and irregular. On longitudinal section the articular cartilage appears slightly irregular. The epiphysis is paler than normal and there is a small soft yellowish white area near its center The epiphyseal cartilage plate is irregular and has lost its normal glistening appearance. On one side there is a considerable amount of tissue that looks like callous tissue. The osseous tissue near the epiphyseal plate appears more dense than usual. The measurements are: Metatarsal IV, left, 4.05 cm.; difference, 1.4 cm.; right, 5.45 cm. Thus there is a loss of 1.4 cm. in the operated bone.

Microscopical Findings. The articular cartilage is covered in places with connective tissue. The cartilage in the immediate vicinity shows evidence of degeneration. The marrow elements appear fairly normal. The trabeculae are bordered by a layer of osteoblast but the nuclei of the osseous tissue are not so prominent as usual. One half of the epiphyseal cartilage plate shows marked evidence of degeneration, being for the greater part replaced by fibrous tissue. The remainder, although somewhat irregular, is of fairly normal structure. In the diaphysis there is considerable replacement of the marrow by fibrous tissue.

SUMMARY ON REMOVAL OF THE EPIPHYSIS AND REIMPLANTING.

It is to be noted that in every instance there is a marked loss in growth but not a complete cessation. This slight growth can be ascribed to the part of cartilage not destroyed or to a certain potential power possessed by the cartilage cells that are not injured. It is also to be noted that a portion of the plate was not injured in some of the experiments, as the incision did not pass directly through the line of separation. Thus a certain amount of growth was possible from the portion that remained.

TABLE VIII.

Exp. No.	Dog No.	Duration	Loss of Growth	Growth of Operated	Growth of Normal
29	30-73	9 days	0.15 cm.	0.1 cm.	0.25 cm.
30	144-85	28 "	0.4 cm.	0.45 cm.	0.85 cm.
31	128-78	51 "	0.5 cm.	0.35 cm.	0.85 cm.
32	123-76	62 "	0.8 cm.	0.35 cm.	1.15 cm.
33	15-50	79 "	1.8 cm.	——	——

3. Cross Incision Through the Metaphyseal Region, Raising and Reimplanting of the Distal Piece.

Method. A cross incision is made through the metaphyseal region.

The tissues about the distal segment are severed along with the joint capsule. The fragment is then raised from its bed and reimplanted, after which it is held in place by sutures into the surrounding tissues. This experiment is practically a reimplantation of the entire epiphysis and metaphysis.

Experiment 34 13 Days. Dog 30-38 Old Series.

Operation. Reimplanted the distal one-third of the bone.

Gross Findings. There is good healing although union is not especially firm. There is no increase in the length of the operated or normal bone.

Microscopical Findings. The articular cartilage appears normal The marrow of the epiphysis is necrotic. The nuclei of the trabeculae of the epiphysis are pale. The epiphyseal cartilage plate is broader than normal but its cellular elements appear practically normal. There is some degeneration of the osteoid tissue of the metaphysis. The remainder of the bone appears normal.

Experiment 35. 44 Days. Dog 130-79.

Operation. Cut across just proximal to the metaphysis of the metatarsal IV of the right hind foot, removed and reimplanted the distal fragment. The bone measures 3.2 cm.

Gross Findings. The joint capsule is thickened and the articular cartilage is not so smooth as normal. On longitudinal section the epiphyseal cartilage plate is found to be broader than normal. The epiphyseal marrow has a mottled appearance. The line of union is quite firm. The measurements are: Metatarsal IV, left, 3.8 cm.; difference, 0.45 cm.; right, 3.35 cm. Thus there is a loss of 0.45 cm. The growth since the operation is 3.35—3.2=0.15 cm., while the normal growth is 0.6 cm. The Roentgenogram shows a considerable irregularity in the epiphyseal cartilage plate. The line of union is faintly visible. As compared with its fellows of the opposite side there is a definite shortening of the operated bone. The entire epiphyseal end of the bone is deformed.

Experiment 36. 44 Days. Dog 41-39 Old Series.

Operation. The record of this experiment was lost, so that it is possible to give only the final results. They are: Loss of growth, 0.5 cm. Growth of the operated bone is zero, while the normal growth is 0.5 cm.

SUMMARY ON CUTTING ACROSS PROXIMAL TO THE EPIPHYSEAL REGION, RAISING AND REIMPLANTING THE DISTAL FRAGMENT.

In practically every instance there is a complete loss of growth following such an operation. Degenerative changes take place at first in the marrow and trabeculae but later there is a regeneration of these parts. The epiphyseal cartilage plate undergoes a gradual degeneration and is practically devoid of further function.

TABLE IX.

Exp. No.	Dog No.	Duration	Loss of Growth	Growth of Operated	Growth of Normal
34	30-58	13 days	0	0	0
35	130-79	44 "	0.45 cm.	0.15 cm.	0.6 cm.
36	41-39	44 "	0.5 cm.	0	0.5 cm.

GROUP IV. LONGITUDINAL INCISION AND REMOVAL OF ONE-HALF OF SECTION.

1. Longitudinal Incision Through the Epiphysis up to Metaphysis and Removal of One-Half.

Method. After exposing the bone a longitudinal incision is made through the articular cartilage and epiphysis up to the line of cleavage between the epiphysis and metaphysis. One of the halves of the epiphysis is then removed leaving the other half intact. The wound is closed in the usual manner.

EXPERIMENT 37. 22 DAYS. DOG 146-86.

Operation. Removed the medial half of the epiphysis of the metatarsal III of the right hind foot. The bone measures 3 cm. The animal died at the end of 22 days.

Gross Findings. A capsule has formed over the end of the bone. There is only a slight amount of fluid in the joint. The articular cartilage is smooth. There is a definite outgrowth of osseous tissue about the stump of metaphysis. The epiphyseal cartilage plate in the immediate vicinity of the severed end appears ossified. The Roentgenogram shows a slight shortening of the bone. Fig. 1. There is a deviation of the cut end to the medial side. There is a certain tendency for a filling up of the gap caused by the excision of the medial half. The measurements are: Metatarsal III, left, 3.7 cm.; difference, 0.4 cm.; right, 3.3 cm. Thus there is a loss of 0.4 cm. in length. The normal bone has increased 0.7 cm., while the operated has increased but 0.3 cm.

Experiment 38. 51 Days. Dog 127-78.

Operation. Removed the medial half of the metacarpal III of the left fore foot. The bone measures 3.0 cm. The animal died at the end of 51 days.

Gross Findings. There is good healing. The articular surface of the operated bone is deflected toward the side of the removed piece. There is a definite tendency to cover the raw surfaces. The epiphyseal cartilage plate appears normal as does the remainder of the bone. The Roentgenogram shows the definite shortening as compared with its fellow of the opposite foot. The bone is deflected toward the medial side. There is a certain evening up of the bone in the region of the epiphyseal cartilage plate. (See Fig. 4.) The measurements are: Metacarpal III, left, (op.) 3.35 cm.; difference, 0.55 cm.; right, 3.9 cm. Thus there is a loss of 0.55 cm. in the operated bone. The growth of the bone is 0.35 cm. as compared with 0.9 in the normal. (See Fig. 4).

Fig. 4. Experiment 38. 51 days. Dog 127-78. Removal of the medial one-half of the epiphysis. Right in photograph, B, third bone from right, 3, is the operated bone. Compare 3B with 3A in order to see the disturbance in growth, as normally they are the same length. Also notice the deviation toward the medial side and compare with the neighboring bone, 4, in which the bending is toward the lateral side, corresponding to the side that was removed.

Experiment 42. 51 days. Dog 126-78. Removal of the lateral one-half of the epiphysis and metaphysis. Right in photograph, second bone from the right, 4, is the operated bone. The lateral one-half of the epiphysis has been removed. Notice the deviation of the bone toward the side from which the piece was removed. Compare with 4, of A, in order to get the amount of shortening, as they are normally of equal length.

Experiment 39. 81 Days. Dog 18-53.

Operation. Cut away the lateral half of the epiphysis of the metacarpal III of the right fore foot. The bone measures 2.6 cm. The animal was killed by gas at the end of 81 days.

Gross Findings. There is good healing. There is considerable irregularity about the articular end of the bone, with a defect in the articular cartilage on the lateral side. On longitudinal section the epipyseal cartilage plate is found to be almost absent. There is a mass of new tissue extending into the epiphysis which appears to be young osteoid tissue. The remainder of the epiphysis appears normal. The Roentgenogram shows the marked shortening, also the irregular form of the bone and the absence of the epiphyseal cartilage plate. The measurements are: Metacarpal III, left, 4.65 cm.; difference, 1.8 cm.; right, 2.85 cm. Thus there is a loss of 1.8 cm. since the operation. The operated bone has increased .25 cm., while the normal has increased 2.05 cm.

SUMMARY OF REMOVAL OF ONE-HALF OF THE EPIPHYSIS.

In each instance there was a definite decrease in the length of the bone which was proportionately greater with the elapse of time.

The bone in every instance showed very minimal amount of growth after such an operation. This fact must be taken into consideration when a piece of an epiphysis is used for transplantation for clinical purposes as advised by some investigators.

Table X.

Exp. No.	Dog No.	Duration	Loss of Growth	Growth of Operated	Growth of Normal
37	146-86	22 days	0.4 cm.	0.3 cm.	0.7 cm.
38	127-78	51 "	0.55 cm.	0.35 cm.	0.9 cm.
39	18-53	81 "	1.8 cm.	0.25 cm.	2.05 cm.

2. Excision of One Lateral Half of the Bone Including the Epiphysis and Metaphysis.

Method. A longitudinal incision is made, extending from the articular surface down through the metaphysis and one of the halves of the bone is removed.

Experiment 40. 13 Days. Dog 110-72.

Operation. Removed the medial half of the metacarpal III of the right fore foot. The measurement of the bone is 2.7 cm. The animal died at the end of 13 days.

Gross Findings. There is good healing. The bone appears to be re-

suming a normal appearance and is encapsulated in fibrous tissue. The measurements are: Metacarpal III, left, 3.05 cm.; difference, 0.15 cm.; right, 2.9 cm. (op.). Thus there is 0.2 cm. growth of the operated bone and 0.35 cm. of the normal.

Experiment 41. 48 Days. Dog 116-74.

Operation. Removed the medial half of the metacarpal IV of the left fore-foot beyond the epiphyseal region. The bone measures 2.7 cm. The animal died on the 48th day after the operation.

Gross Findings. There is good healing. The joint is covered over and the articular cartilage that remains is smooth. The end of the bone is deflected toward the medial side. The exposed piece of epiphysis and diaphysis is covered by new cortex. The epiphyseal cartilage plate appears slightly narrower than normal and there is a loss of vascularity of the neighboring bone. The measurements are: Metacarpal IV, left (op.), 2.9 cm.; difference, 0.4 cm.; right, 3.3 cm. Thus there is a loss of 0.4 cm. in length. The operated bone has increased 2.9—2.7=0.2 cm. in length, while the normal growth has been 3.3 cm.—2.7 cm.=0.6 cm.

Experiment 42. 51 Days. Dog 126-78.

Operation. Removed the lateral half of the epiphysis and metaphysis of the metacarpal IV of the left fore foot. The entire length is 3.0 cm. The animal died at the end of 51 days.

Gross Findings. The bone is deflected toward the lateral side. There is a definite tendency to encapsulate the end of the bone, also to form a new wall of cortex on the lateral side. The remainder of the bone appears normal. The Roentgenogram shows the shortening and deflecting of the bone. The epiphyseal cartilage plate is irregular. Notice the tendency to reëstablish the original form of the bone. (See Fig. 4.) The measurements are: Metacarpal III, left, (op.) 3.4 cm.; difference, 0.4 cm.; right, 3.8 cm. Thus there is a loss of 0.4 cm. The growth of the operated bone has been 3.4—3.0=0.4 cm., while the normal measures 3.8—3.0=0.8 cm. (See Fig. 4.)

SUMMARY ON EXCISION OF ONE LATERAL HALF OF THE EPIPHYSIS AND METAPHYSIS.

There is a definite hindrance in growth after the removal of such a portion of bone. The disturbance is about the same as if only a half of the epiphysis up to the line of cleavage of the epiphyseal cartilage plate is removed.

TABLE XI.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
40	110-72	73 days	0.15 cm.	0.2 cm.	0.35 cm.
41	116-76	48 "	0.4 cm.	0.2 cm.	0.6 cm.
42	126-78	51 "	0.4 cm.	0.4 cm.	0.8 cm.

3. Removal of the Longitudinal Half of the Entire Bone.

Method. The entire bone is split longitudinally and one-half is removed. The wound is then closed in the usual manner.

Experiment 43. 3 Days. Dog 150-87.

Operation. Split the metacarpal IV of the left fore foot and removed the lateral one-half. The bone measures 3.6 cm. The animal died in 3 days.

Gross Findings. The duration of the experiment is too short to allow any deductions and merely shows the primary healing.

(To be continued.)

The following notice, which is being sent out from Washington, should be heeded by medical men as well as by those in other branches of the service:

Treasury Department, Washington,
December 4, 1918

To the Soldiers and Sailors of America:

Approximately four million officers and men of the Army and Navy are now insured with the United States Government for a grand total of almost thirty-seven billion dollars

You owe it to yourself and to your family to hold on to Uncle Sam's insurance. It is the strongest, safest, and cheapest life insurance ever written.

For your protection Uncle Sam has established the greatest life insurance company in the world—a company as mighty, as generous, and as democratic as the United States Government itself. Just as Uncle Sam protected you and your loved ones during the war, so he stands ready to continue this protection through the days of readjustment and peace.

The privilege of continuing your Government insurance is a valuable right given to you as part of the compensation for your heroic and triumphant services. If you permit the insurance to lapse, you lose that right, and you will never be able to regain it. But if you keep up your present insurance —by the regular payment of premiums—you will be able to change it into a standard Government policy *without medical examination.* Meantime you can keep up your present insurance at substantially the same low rate. The Government will write ordinary life insurance, twenty-payment life, endowment maturing at age 62, and other usual forms of insurance. This will be Government insurance—at Government rates.

The United States Government—through the Bureau of War Risk Insurance of the Treasury Department—will safeguard you and your loved ones with the spirit and purpose of a Republic grateful to its gallant defenders. To avail yourself of this protection, you must keep up your present insurance. Carry back with you to civil life, as an aid and asset, the continued insurance protection of the United States Government.

Hold on to Uncle Sam's insurance.

W. G. McADOO, *Secretary.*

A STUDY OF BURIED BONE.

BY JOHN FRANCIS COWAN AND LEONARD W. ELY, SAN FRANCISCO.

(From the Laboratory of Surgical Pathology, Leland Stanford Junior University.)

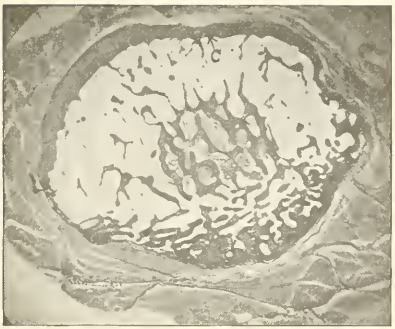
THE material for this study was gained in a series of knee joint resections in the dog, the results of which have been published recently.[1] In ten of these cases the patella was imbedded: in one a fragment of the femoral condyle; in one, a fragment from the tibial head. The bone was buried in the animal from which it had been removed a few minutes previously. An incision was made deep in the muscles on the lateral aspect of the thigh, and the bone was inserted. The wound was sutured in two layers, and was dressed with collodion and gauze. The operated limb was put in a plaster spica. The wounds healed by first intention. The animals died or were killed from 14 to 432 days after operation. At the autopsy the bone was removed with the surrounding tissue, in which it was firmly imbedded. The material was fixed in alcohol or Orth's fluid, dehydrated in alcohol, decalcified in 5% nitric acid, run up in the alcohols, and imbedded in colloidin. Sections cut with a microtome, were stained with hematoxylin and eosin, and with the van Gieson stain. All operations were done under ether anesthesia.

DOG 8. 432 Days. The dog was killed by ether anesthesia. Bone removed, with surrounding muscle tissue.

Histology. The patella is almost completely encapsulated by a thin layer of fibrous tissue, though in places over the cartilage the muscle tissue is immediately contiguous, and the fibrous capsule is wanting. The cartilage cells stain fairly well, and the cartilage itself seems to be in a good state of preservation, except at its surface, where it is irregular and notched. In these irregular notches fibrous tissue is seen. The bone buttress under the cartilage is almost gone, and the trabeculae in this region are scant and small.

The bony "cortex" on the other side of the patella is being replaced by fibrous tissue. The marrow is fatty, except near the center, where there is an area in which the marrow is fibrous. No rarefying osteitis is seen. In this central area many of the trabeculae stain deeply with hematoxylin at their borders. A few bone cells stain, but the bone is dead. The trabeculae also are thicker than in the rest of the patella, but their interior portion does not stain so well, and has empty lacunae. No connection can be seen between this fibrous marrow and the fibrous capsule.

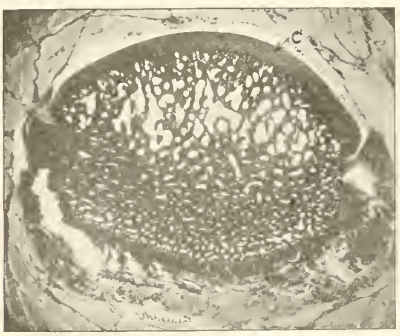
Encapsulation. Erosion of cartilage at its surface, but persistence of most of the cartilage in good shape. Much dead bone still present, but absorption of many of the trabeculae. Fatty and fibrous marrow The bone buttress under the cartilage is almost gone.



Dog. 8B.

Dog 12. 14 Days. The dog died of hemorrhagic septicemia.

The Patella. A well-marked fibrous capsule is present. The surface of the cartilage is fairly smooth for most of its extent, and is not ad-



Dog 12B.

herent to the capsule, except for a short distance at its ends. Its cells do not stain. It is evidently dead. The bony cortex (on the part of the patella not covered by cartilage) is continuous with the fibrous capsule and stains irregularly in streaks and patches with hematoxylin. The fibres of the capsule seem to run into the bone. The trabeculae themselves are abundant and thick, but all the bone in the specimen is dead and stains very poorly. The marrow spaces of the denser part of the bone are engorged with blood.

Encapsulation. Adherence of small part of cartilage to capsule. the rest of its surface smooth. No bony absorption. Death of bone and cartilage.

Dog 13. 88 Days. The dog died of pneumonia.

The patella, of approximately the same size as when buried, is encapsulated by fibrous tissue. The cartilage persists, but is irregular in thickness and in outline. Some of its cells stain well. Many of them retain their capsules. Some have lost them. The cartilage is being replaced by fibrous tissue at its surface, and immediately beneath it is a thin layer of lymphoid marrow. The bony buttress under the cartilage has disappeared almost entirely.

The layer of "cortical" bone on the rest of the patella has been changed to fibrous tissue, so that the line of division between the buried specimen and the capsule cannot be exactly made out.

The trabeculae immediately under the cartilage are small and scant. In the rest of the bone near the circumference they are somewhat diminished in number and size. The marked change in them, however, is in their structure. They seem to be fading away. The ground substance has been mostly absorbed. The trabeculae have a hyaline and granular appearance.

In the marrow bordering these trabeculae are layers of cells, polymorphonuclears, endothelial leucocytes and lymphocytes, and an occasional myelocyte. The rest of the marrow is mostly fatty.

In the center of the specimen the trabeculae present the same appearance of absorption, but are not edged by the cellular layers. Here the marrow consists of dense fibrous tissue. In other words, where the marrow is fatty, the trabeculae are bordered by a thin layer of lymphoid marrow; where it is fibrous, they are not.

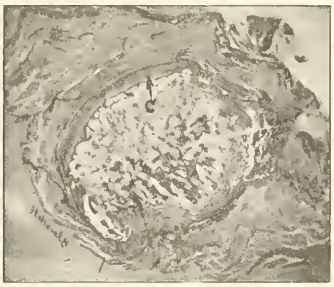
It is to be noted that in spite of the virtual disappearance of the bone, no evidence is present of rarefying osteitis—no osteoclasts in Howship's lacunae.

The marrow throughout the specimen, except, of course, in the fibrous areas, is engorged. The "blood sinuses" are full of blood. This is the usual appearance of the marrow in animals dying of infectious disease. In other words, the marrow in this specimen of buried bone removed from an animal which died of an infectious disease was still reacting as marrow ordinarily does.

Encapsulation. The cartilage is eroded, but its cells stain fairly well. The buttress has disappeared. The trabeculae are undergoing absorption, but not by osteoclasts. The marrow is fatty and fibrous, and is engorged.

Dog 14. 117 Days. The cause of death was not ascertained.

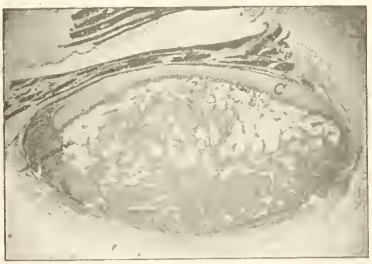
The patella has a complete fibrous capsule. The cartilage in some slides remains, except at one end, though irregular in outline. In other slides it exists only as islands. Its cells stain fairly well. Underneath the cartilage the bone trabeculae are rather thin and sparse, and the buttress of bone is almost gone. In sections where the cartilage exists as mere islands, the fibrous tissue can be seen entering the bone among the islands. The marrow underneath the cartilage is for



Dog 14B.

the most part fatty, the rest fibrous. The cortical bone on the side opposite the cartilage is being replaced by fibrous tissue. The trabeculae stain very poorly, and irregularly, and are dead. They look as if they were breaking down. The marrow itself is engorged with blood, indicating that the animal died of an infectious disease.

Encapsulation. Disappearance of much of the cartilage, and of the buttress. Bone trabeculae dead and disappearing, but not by the action of "osteoclasts." Fibrous and fatty marrow.



Dog 15B.

Dog 15. 240 Days. The dog was killed with ether.

The patella, apparently somewhat diminished in size, is encapsulated by fibrous tissue. The cartilage looks fairly healthy. Under the high power its cells stain fairly well, but their capsules are indistinct. Its surface is irregular and notched, and has been encroached upon by fibrous tissue. It is irregular, also, in thickness. It is much thinner near the middle than at the side. Under the cartilage is a buttress of osteoid tissue, much thinner than normal. Directly under this buttress the marrow is fatty and the trabeculae are very scant.

In the centre of the specimen is an area of fibrous marrow which extends down to the dense layer of cortical bone on the side opposite the cartilage, and this fibrous tissue can be traced along through the dense bone to the periphery, where it communicates with the fibrous tissue of the capsule. The rest of the marrow is fatty.

The bone trabeculae in the central area and in the portion of the bone opposite the cartilage are quite dense and have lost their cells. They shade into the fibrous marrow. One gets the impression that the bone is being replaced by fibrous tissue, but the bone itself stains well.

The cells of the cortical bone are also missing; a very few are present. The fibrous tissue at the periphery is encroaching upon the bone Here and there blood vessels can be seen pushing their way through the dense bone. At the place where the original tendon ran into the bone, its fibres persist, and its cells change into cartilage cells as it runs into bone

A few osteoclasts can be found by diligent search, but rarely in Howship's lacunae.

Encapsulation. Much of the bone persists, though it is dead. The cartilage is irregular, but still alive. Its buttress consists of osteoid tissue. The marrow is fatty, fibrous and lymphoid.

Dog 16. 97 Days. Cause of death: Pulmonary embolus, old, organized pneumonia, organized cardiac thrombus.

The patella is surrounded by muscle and fibrous tissue. The cartilage is thin and very irregular, and at its surface it is being replaced by fibrous tissue. Some of the cells of the portion remaining are in fair condition, but many are dead. Most of the bony cortex of the rest of the patella also has been replaced by fibrous tissue. The trabeculae are thin and sparse, and have lost their cells. They are dead. The basement substance of many of the trabeculae is breaking up, apparently in the process of absorption, and stains irregularly and poorly. No evidence of rarefying osteitis is present.

The marrow is mostly fatty; some areas of lymphoid marrow are present.

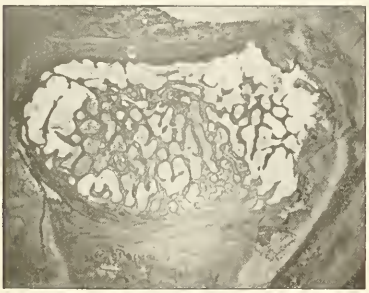
Encapsulation. Partial disappearance of cartilage and of bone, and the death of the remainder. No rarefying osteitis. Fatty and lymphoid marrow.

Dog 17. 347 Days. The dog was killed with chloroform.

The patella is well encapsulated. The cartilaginous portion is intimately connected with the capsule, and its superficial portion has been replaced by fibrous tissue. One end of of the cartilage strip has been replaced by fibrous tissue. The remaining cartilage itself is in fairly good condition. Its cells stain well. The surface of the cartilage is irregular. Most of the bony cortex of the rest of the periphery has been replaced by fibrous tissue.

The bone trabeculae are somewhat scantier than normal. A few of their cells are present, especially near the periphery of the specimen, but most of the lacunae are empty. The bone is dead. The marrow is largely fibrous and in this fibrous tissue are many blood vessels. Es-

specially near the periphery of a portion of the specimen the marrow is fatty. Here and there an osteoclast can be seen.



Dog 17B.

Encapsulation. The cartilage has been largely replaced by fibrous tissue. Part of the bone has been replaced by fibrous tissue. Most of the bone is dead. The marrow is mostly fibrous.

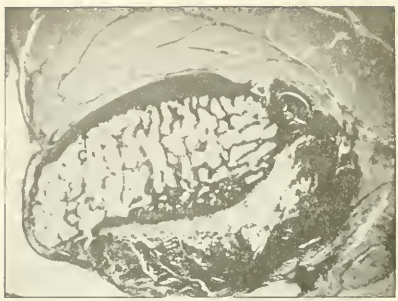
Dog 18. 317 Days. The dog was killed.

The patella (smaller than when buried) is encapsulated by fibrous tissue. About one-half the cartilage is absent, and the marrow is separated from the encapsulating tissue only by a thin layer of osteoid tissue. The rest of the cartilage persists, and is eroded at its surface. Its cells stain well, but have lost their capsules. The layer of osteoid tissue, thinning out, can be traced along under a portion of the cartilage to form a sort of buttress, finally ceasing. No bony buttress is present anywhere. Only a few very small trabeculae are seen below the cartilage. Near the periphery of the bone the trabeculae are small and scant, and the marrow is fatty. The trabeculae show in several places near the center well marked rarefying osteitis (osteoclasts in Howship's lacunae). Most of the bone is dead. The marrow in the small central portion consists of fibrous tissue. This fibrous tissue can be traced in one place almost to the periphery, on the side opposite the cartilage. The layer of cortical bone on the side opposite the cartilage is very thin, and evidently is being replaced by fibrous tissue. In places the bone tissue has been entirely replaced by fibrous tissue. One small patch of lymphoid marrow is seen beneath the persisting strip of cartilage.

Encapsulation. Partial disappearance of cartilage and disappearance of bony buttress. Partial disappearance of bone trabeculae. Almost all the remaining trabeculae have lost their cells. Dead bone. The marrow is fibrous and fatty, with a little lymphoid.

Dog 19. 40 Days. The cause of death is unknown.

The patella is partly encapsulated by fibrous tissue. The cartilage is faced by muscle tissue, whose fibres actually seem to run into it at



Dog 19B.

an angle, the line of junction not being sharp. The bony cortex of the patella is continuous with the surrounding fibrous tissue in most places. In one area there is a typical capsule. A complete true capsule is absent, in other words.

The structure of the cartilage is fairly well preserved. The cells stain fairly well, and the basement substance appears normal. Apparently a small piece has disappeared from one end. The subjacent buttress is present under about half the cartilage; wanting or diminished under the other half. In the region of the former the marrow is fibrous; in the latter, lymphoid and fatty. Throughout about two-thirds of the patella the marrow is delicately fibrous; throughout one-third it is fatty and slightly lymphoid.

The trabeculae stain poorly and irregularly. Their cells are absent. Fibrous tissue appears to be replacing some of them, and they are lessened in thickness and in number. In the region of the fatty marrow, where the trabeculae are sparse, a very little typical rarefying osteitis is seen—osteoclasts.

The "blood sinuses" are greatly engorged. The trabeculae appear to be breaking up and to be undergoing absorption, but for the most part not lacunar absorption.

Encapsulation not complete. Bone trabeculae disappearing; cartilage also. Fibrous and fatty marrow. Absorption of much of the bone. Death of the rest. Engorgement of blood sinuses. Buttress partially gone.

Dog 20. 304 Days. The dog was killed by chloroform anesthesia.

The patella is surrounded by a capsule of fibrous tissue, very delicate in some places. The bony cortex is very thin, and in places is absent, being replaced by fibrous tissue. The bone trabeculae stain well, but in places the bone cells are absent, especially in the interior of the trabeculae; in others they are present and stain well, especially at their border—"border apposition." The trabeculae are sparse. The buttress beneath the cartilage is absent, and the normal piling up of trabeculae; on the other side of the bone, the thick "cortex" is also

Dog 20.

absent. The marrow is fatty, with a very few small patches of lymphoid marrow. No fibrous marrow is seen.

The cartilage is thin, and is eroded and irregular at its surface. Fibrous tissue is replacing its superficial portion. Its cells stain deeply with hematoxylin and are in a good state of preservation. Some have lost their capsules. A few capsules are without cells. Blood vessels are abundant in the marrow.

Encapsulation. Replacement of most of the cortex by fibrous tissue. Partial absorption of bone trabeculae; some of the remaining trabeculae are dead, but most of them living. Cartilage thin and eroded, but still living. Subjacent buttress absent. Marrow mostly fatty, with a little lymphoid.

Dog 21. 255 Days. The dog was killed by chloroform.

Piece of head of tibia. At autopsy this seemed to have diminished in size.

The surface of the cartilage is slightly irregular and its superficial portion has been replaced by fibrous tissue, which separates it from the surrounding muscle. The fibrous capsule is complete about the rest of the buried fragment, and has not extended into the marrow, although as there was no bone cortex, it had free access to the interior. The marrow is fatty and lymphoid. The trabeculae are rather scanty, and the bone buttress is absent under part of the cartilage. The bone lacunae of the trabeculae are empty.

Encapsulation. Degeneration of the surface of the cartilage. Partial absorption of bony buttress and trabeculae. Death of bone. No fibrous change of the marrow.

Dog 22. 47 Days. The dog was killed with chloroform during pneumonia.

The bone fragment, a piece of the femoral condyle, has a fibrous capsule, and with this capsule the cartilaginous portion is intimately connected. In places the surface of the cartilage is fibrillated. The cartilage itself seems fairly normal, but the buttress beneath it is absent. The trabeculae are sparse, and stain irregularly. They seem to be undergoing absorption. Their cells are absent for the most part

The marrow is lymphoid. No fibrous marrow is present, and the fibrous tissue from the capsule has no tendency to push into the bone. The marrow stains well, and contains blood vessels and sinuses.

Encapsulation. Beginning bone absorption. Some of the cells of the trabeculae still alive, most of them absent. Cartilage in good condition, except at its surface. The subjacent buttress has disappeared.

CONCLUSION.

A patella, or the fragment of another bone, imbedded fresh in the muscle of the animal from which it was removed, has a tendency to disappear, but does not disappear, at least for a long time. In none of our cases had it disappeared completely. Its structure becomes less dense.

The bone tissue itself may be replaced by fibrous tissue, especially at or near the circumference, or it may be absorbed. Absorption is the rule in the interior. Occasionally typical rarefying osteitis by osteoclasts is seen. More frequently the process seems to be one of simple absorption—"halisteresis." The method of absorption is often difficult to determine, for about many of the trabeculae there are no giant cells, no leucocytic infiltration, and no increased vascularity of the marrow.

Many of the cells disappear early from the bone. Others stain well after the expiration of a long time. Death of bone is the rule.

A patella, with a complete investment of bone and cartilage, does not resist absorption better than a bone fragment whose marrow is exposed to the surrounding tissue.

A blood supply is established in the marrow of the buried bone.

The marrow has a tendency to become fatty and fibrous, though patches of lymphoid may persist. It is engorged in animals who have died with an acute infectious disease, as is the marrow of normal bone in such circumstances. In other words, it is functionating as marrow.

Cartilage becomes eroded at its surface, and is replaced by fibrous tissue. Sometimes it disappears completely in areas. Its cells often stain well after a long time. Sometimes they die after a shorter time. The buttress underneath the cartilage almost always disappears early.

Judging from appearances, the buried bone becomes smaller in size.

Roughly, the changes in bone and cartilage are the same as those seen in arthritis of Type I—atrophic, or proliferative arthritis.

REFERENCE.

[1] Bone and Joint Studies. I. Leonard W. Ely and John Francis Cowan, Stanford University, Cal. Published by the University, 1916.

NOTE: The illustrations are all low-power photo-micrographs. "C" refers to the cartilage.

PSEUDOCOXALGIA FOLLOWING TRAUMATIC DISLOCATION OF THE HIP IN A BOY AGED FOUR YEARS.*

BY R. C. ELMSLIE, M.S., F.R.C.S., LONDON, ENGLAND,

Orthopædic Surgeon, St. Bartholomew's Hospital.

THE x-ray photographs presented are of the left hip of a boy who came to my out-patient department at St. Bartholomew's Hospital on February 2nd, 1914. There had been a fall on January 25th and upon examining the boy I found that his left hip was dislocated. As dislocation of the hip by violence at so early an age is so rare as to be unrecorded in surgical literature, I had an x-ray photograph taken in the dislocated position and then reduced the dislocation upon the x-ray table. A second plate was then taken to show the reduction. The x-rays show that at this time the head of the femur was perfectly normal. As the boy lived some distance out of London, the hip was fixed in plaster-of-Paris for safety, for a fortnight. The plaster was then removed and the hip left to recover its mobility.

FIG. 1.—Posterior view of left hip, Feb. 2, 1914, before reduction of dislocation.

* A paper read before the British Orthopædic Association.

On April 12th, 1915, the patient was brought back to the hospital because since January of that year he had been limping and complaining of pain in the hip after walking. Until January there had been no trouble, and there had never been any pain at night. The hip was again x-rayed, a roughening of the head of the femur found which was thought to be due to tuberculous disease, and the hip was fixed in plaster-of-Paris. I did not see the boy at this time, nor have I a copy of the x-ray.

The hip was kept in plaster-of-Paris until September 4th, 1915, when I next saw the patient. On examining the x-ray I at once recognized it as showing the characteristic changes of pseudocoxalgia, as described first by Calvé. An x-ray taken at this date I am able to show. It shows the irregularity of the epiphysis of the head of the femur, with thinning where the upper margin of the acetabulum presses upon it, and also the broadening of the neck of the bone which is to some extent overlapped at the edges by the epiphysis.

FIG. 2.—Anterior view, left hip, Sept. 5, 1915, showing characteristic changes of pseudocoxalgia.

All treatment was stopped and the boy allowed to walk freely upon the limb.

I have kept the case in view up to the present time. There is now

evident thickening of the neck of the femur, which can be felt. Movements of the hip are free except full abduction. The last x-ray, taken in February, 1918, four years after the original accident, shows great thickening of the neck of the femur, and a very broad epiphysis, which, however, now has a smooth upper surface.

FIG. 3.—Anterior view of left hip, Feb. 2, 1918, showing the thickened neck and wide, thin epiphysis characteristic of the late stage of pseudocoxalgia.

These x-ray photographs are instructive for two reasons. In the first place, following up this case over a period of four years has shown that the bony surface of the head of the femur eventually becomes quite smooth. This, I think, shows that the roughening apparent in the early photos of these cases of pseudocoxalgia is a roughening of the bony nucleus and not of the cartilage which covers it. This might also be inferred from the fact that in these cases the movements of the joint remain free throughout, except, perhaps, for short periods in which a transient synovitis of the joint occurs.

In the second place the occurrence of pseudocoxalgia in this case as a direct sequel of a traumatic dislocation, suggests a possible anatomical cause for the condition. It is well known that pseudocoxalgia occurs exclusively in children aged from four to seven, and that there is usually some preceding accident. It is also noticeable that changes which are exactly similar occur in the bony muscles of the head of the femur in children with congenital dislocation of the femur after reduction of the dislocation. The changes, being chiefly in the bony nucleus, at least in the early stages, suggest that there may be some nutritional disturbance of this nucleus. I suggest that the condition is due to an interference with the nutrition of this nucleus, due to an injury to its vascular supply, which at this period must be conveyed in the *ligamentum teres*. An injury to this ligament may quite well occur in a traumatic dislocation of the hip and also in the reduction of a congenital dislocation. At a later stage, when the neck of the femur is less cartilaginous, it is likely that a considerable vascular supply may reach the epiphysis of the head of the bone through the retinacula. Possibly when the supply through the *ligamentum teres* is sufficient, that through the retinacula increases, and this increased vascularity around the neck of the femur may help in causing the thickening of the femoral neck.

For comparison I present some other x-rays of cases of pseudocoxalgia from my collection. In one of them the condition arose after a definite arthritis which occurred during an attack of chorea. In another a late stage of the condition in an older child is shown. The neck is very thick and the head broad and thin, but smooth, as in the case now reported.

Discussion.

Mr. Harry Platt gave an epidiascope demonstration of radiograms of cases of pseudo-coxalgia. He added: These are two plates showing flattening of the head of the femur, where the condition does not fall into the class of pseudo-coxalgia. I think they are cases of tuberculous foci in the neck of the femur.

The first of my cases is that of a child of four years, and it is a very advanced and typical case of bilateral pseudo-coxalgia. You can easily see the thinned-out head and fragmented nucleus. On the other side, the flattening at the head is not so marked. Major Elmslie anticipated what I am going to say. From the observation of a dozen cases which I have followed for four years, what has impressed me has been that the accepted pathology, looking upon these cases as purely traumatic cases, seems to be wrong, though it is impossible to deny that this condition may develop after a definite severe injury such as that which Major Elmslie demonstrated, or an injury resulting from reduction of a congenital hip dislocation. The question which I have worked at was as to whether flattening of the head of the femur is the prime lesion in these cases or whether the primary lesion is in the neck of the femur. And, if that is so, is it possible to get a flattening of the head of the femur in such con-

ditions as tuberculosis of the neck of the bone? There are two plates in my series of definite cases of tuberculous foci in the neck of the femur, both showing a flattened head, although the head of the femur is not fragmented and does not show hyper-calcification. In the bilateral cases of pseudo-coxalgia I have seen there is no history of trauma. In one case the patient had been treated for two years on a Thomas hip splint for so-called right tuberculous hip, and when I saw him he had both right and left hips affected, the left showing more advanced pseudo-coxalgia than the right. There was no weight-bearing on the right side but flattening had developed in spite of the rest. In this patient's case there is no history of injury. I feel that this appearance of flattening of the head of the femur is not pathognomonic of any one disease, but may be produced by nutritional changes, the result of an injury or of some pyogenic or tuberculous infection of the neck of the femur. I should particularly like to hear what Capt. Kidner has got to say on this subject as I know it is a subject which he also has investigated along the same lines.

THE PRESIDENT: These are most interesting cases which have been illustrated by Major Elmslie and Captain Platt, and I hope we shall have an interesting discussion on them. There is one point I would remind you of, and that is that there are changes in the bony nucleus of the femur in these cases similar to those which occur in Schlatter's disease and in Kohler's disease also. There is an apparent likeness in these cases; whether there is a real likeness I do not know. It is a point which it will be interesting to have brought out, and I hope some speakers may enlighten us on it. I ask Capt. Kidner to make some remarks.

CAPTAIN KIDNER, U. S. A.: The work of Legg, which far preceded the work of Perthes on this condition of pseudo-coxalgia, seems to have given the clearest possible explanation of the causation. Legg felt, in 1910 or 1911, that the condition was one of traumatism of vessels in the neck of the femur with secondary loss of substance in the sub-epiphyseal line and a partial loss of the deposition of lime salts, with the irregular thickening which is so common in all these cases. That explanation seemed, at the time, satisfactory. But then we began to discover cases in which there was no history of traumatism and it occurred to many men that there might be an infection which was localized in the neck of the femur through a thrombosis which interfered with the nutrition of the upper end of the neck, with the epiphyseal line secondarily involved with the resultant loss of calcium deposit. I had a very interesting case of that sort in 1913. The skiagram showed a cavity, such as that which Mr. Platt has now shown, and which I believed to have been an osteomyelitic abscess. I drained it and got from it a low-grade staphylococcus which was culturable. Removal of the focus was followed by a condition which presented the typical x-ray picture of pseudo-coxalgia, followed by recovery without any subsequent flattening of the head. The cases which Captain Platt and Major Elmslie have shown are particularly interesting from various standpoints. In the first case Major Elmslie showed he gives us the pictures and attributes the appearance of the diseased part sometime afterwards to the traumatism. It seems to me probable that the course of events has been the reverse. I think the skiagram taken at the time of the dislocation and that taken shortly afterwards both clearly show early stages of pseudo-coxalgia, not in the changes of the head but in the sub-epiphyseal line. But it is difficult to tell from the reproductions. Still, I imagine there would tend to appear in the original x-ray plates a marked scalloping of the sub-epiphyseal line and a moderate cavity formation in the epiphysis.

In regard to Captain Platt's cases, I very much wonder what are his grounds for saying the condition was tubercular. I have wondered whether he operated or simply based his opinion on the course of the disease. It seems to me that his cases, which he regards as tubercular, were clear cases of staphylococcic or other low-grade infection with abscess formation in the neck and with secondary changes in the head due to interference with circulation.

MR. LAMING EVANS: I would ask Major Elmslie one question and that is whether he has come across cases where the acetabulum has been involved in these cases. I have a skiagram of a case which I take to be one of pseudo-

coxalgia in which the acetabulum was definitely affected. If so, the theory of Major Elmslie is, it seems to me, difficult to maintain.

MAJOR ELMSLIE: I do not think there is much for me to reply to. In answer to Mr Laming Evans' question, I have seen cases in which there were changes in the acetabulum and I think I am right in saying that Calvé, in his original paper which, I believe, was published in 1909, mentioned that, in some cases, particularly in rather advanced cases with a lot of alteration in the head, there may be a little roughening and irregularity of the upper part of the acetabulum. I do not think that affects any theory as to the origin of the condition because I do not think that roughening of the acetabulum means anything more than adaptive changes in the acetabulum. Perhaps I did not explain myself as clearly as I meant to in putting forward what Mr. Laming Evans regards as the vascular theory. I should rather call it the nutritional theory, and I would prefer to say that I think the condition of flattening and mushrooming of the head of the femur, which we call, in this country, pseudo-coxalgia is due to some change in nutrition in the epiphysis of the head of the femur. I agree with the President that the changes are similar to the other changes one sees in the epiphysis or tubercle of the tibia in Schlatter's disease and in the heel in a condition which, I believe, was first described by Haglund. I suggest that these changes are nutritional, that they are due to various causes, but what I wish to suggest is that, in certain of the cases, such as those originally described by Calvé, in which there is no other lesion but apparently a healthy child without any abscess or infection of the neck of the femur and without any acute symptoms, this condition of the head of the femur occurs and that in those cases the lesion may be due to nutritional changes which are started by an alteration in the vascular supply through injury to the ligamentum teres. I do not regard all these cases of change in the head of the bone as of uniform origin.

CAPTAIN PLATT (in reply): In answer to Captain Kidner's remarks concerning the diagnosis of tuberculosis, I must admit it was rather a "label" than otherwise, though the three cases give a definite von Pirquet reaction and they are all young children. The other cases of definite pseudo-coxalgia in my series have given negative reaction. Another interesting point is that every case I have seen has got well marked signs of rickets. With regard to the original description of Calvé, in 1910, the point he laid stress on was the enlargement of the head of the femur, so much so that it could easily be felt. In one of my cases the head of the femur is greatly enlarged so that it forms a marked prominence in the anterior aspect of the thigh. I have not found this sign in any of the others. It is possible that these cases, which are still under treatment, with definite foci in the neck of the femur, may be either pneumococcal, staphylococcal or some other form of low-grade infection. But they all show extreme restriction of joint movement at the present time and a positive von Pirquet reaction and one is looking upon them, for purposes of practical treatment, as tuberculous. I think there will have to be some line drawn between the cases which definitely progress to the thin, flattened-out head with fragmentation and—a point which has not been emphasized enough—the marked hyper-calcification in the nucleus, and the other type of case, namely, that where, with a focus in the neck, there is simply flattening of the head, but the neck shows atrophic changes such as you find in a typical tuberculous joint.

THE TREATMENT OF CHRONIC OSTEOMYELITIS DUE TO GUN SHOT INJURIES.

BY C. F. EIKENBARY, CAPTAIN, M.R.C., U.S.A.

Chronic osteomyelitis, due to gun shot injuries, differs only in minor ways from chronic osteomyelitis in civil life. After all, we are dealing with exactly the same pathology, excepting that in gun shot injuries we may have to deal with some foreign substances, and not infrequently, with an ununited fracture as well. But the surgical procedure that is best in military surgery, is also the best procedure in civil surgery.

Almost without exception cases of chronic osteomyelitis, civil or military, have sinuses leading down to necrosed bone. Occasionally a sinus may heal, leaving a sequestrum, usually small, surrounded by a small quantity of pus, which pus, having very slight virulence, may permit of the condition remaining dormant for an indefinite time. It is the writer's opinion, however, that sooner or later, practically all these cases have exacerbations, and therefore should be cleaned out without delay.

It has seemed to the writer that in civil surgery these cases were too frequently treated by the curette—the bone or sinus "scraped" as the layman is wont to say—with the result that the sinus either re fused to heal, or else healed only temporarily, the tract soon breaking down and discharging pieces of necrosed bone. And thus the patient goes on with his daily or tri-weekly dressings over a period of months or years. Cases of discharging sinuses persisting for many years, and finally being cured by an amputation are all too frequent.

From June 12, 1917, until November 20, 1917, the writer had an opportunity of seeing and operating a great many cases of chronic osteomyelitis (gun shot cases), in Bellahouston Hospital, Glasgow, Scotland. In all these cases sinuses had persisted for a long time, and in all of them sequestra could be demonstrated by the x-ray. In many instances there were metallic substances as well. Frequently the metallic substances were entirely surrounded by perfectly healthy bone and therefore demanded no interference.

Operation. If possible, an Esmarch and tourniquet were always applied. The operative procedure was a rather radical one. A long incision was made over the necrosed area, as indicated by the x-ray. If the sinus opening was near the sequestrum, and at a point favorable

Gunshot Injury to Tibia.

Compound fracture. Healing with very little deformity. Osteomyelitis, with sequestra. Dotted line shows the line of bone incision. Appearance after operation.

for the avoidance of blood vessels and important nerve structures, then it was included in the incision. If not, it was disregarded. The bone having been exposed over a large area, the sinus leading down to the sequestrum was searched for. When found, and this was usually quite easy, the bone was chiseled away at this point, and the sequestrum removed. The length of the necrotic area was then estimated, and in this we were guided not only by the probe but by the x-ray as well. Having estimated the length of the necrotic area, both distally and proximally, the bone was chiseled away for a distance of approximately an inch above and below the diseased region, the chisel at either end of the bone incision being driven in in a very *slanting manner.* If feasible, the sides were also cut away either by a chisel or a bone biting forceps. No *sharp angles* or *spicules* were ever left. In the end we had a large depression, the floor of which was the healthy bone below what had been the necrotic area. If any wall were left, it also was made perfectly smooth and very slanting. The curette was

not used at all, except occasionally to remove pieces of bone already cut loose by the chisel.

A couple of sutures were placed at either end of the incision, and the wound firmly packed with plain sterile gauze strips. No antiseptic gauze was ever used. At the end of twenty-four hours the original packing was removed and the wound lightly packed with the same type of sterile gauze. Within a few days the packing merely extended through the soft parts.

The whole aim of the operation is:

1. To get rid of all necrotic bone.
2. To avoid leaving any cavity at all.
3. To avoid spicules, rough areas, etc.

Results. Almost without exception, these cases healed within four weeks. Many were healed within three weeks, and in one instance healing was complete in two weeks.

The procedure may possibly be better understood from the more or less schematic drawing which accompanies this paper.

Book Reviews

Over Beenvorming. Dr. Murk Jansen. E. J. Brill, Leiden, 1918.

The author, who is well known to many orthopædic surgeons by his excellent book on Achondroplasia, has made another remarkable contribution to the orthopædic science by this book, which is dedicated to Sir Robert Jones. After a thorough discussion of the mechanical laws of internal bone architecture the book deals with the changes of the internal architecture of bones in many of the most common deformities, such as severe flat foot, kyphosis, scoliosis, ankylosed knee, coxa vara, spondylitis deformans, etc.; also certain deformities of joints of animals. The illustrations are excellent and they alone would make the book very valuable even for those who cannot read the Dutch language. We hope that the author will, in time, issue a translation into English, French, or German, to give the volume a wider publicity, which it deserves.—*C. H. Bucholz.*

Orthopædic Surgery. Edited by Edwin W. Ryerson, M.D. The Practical Medicine Series, 1918. Chicago: The Year Book Publishers

The synopsis, which is really a review of the literature in orthopædic surgery, with the valuable experience of the author combined, makes the information contained in this volume very valuable to the orthopædic student. It is particularly interesting for the orthopædic war surgery, to which considerable space is given, with descriptions and illustrations of the splints, which is valuable to one who has not had the opportunity of using these new forms of apparatus.

The book should be of interest also to the general practitioner, as it is concise, and will help in the diagnosis and in the advice which should be given to patients suffering from orthopædic difficulties.—*L. T. Swaim.*

Current Orthopaedic Literature

Numerals at head of each abstract are for use in connection with the official "Classification of Orthopædic Literature," published in the JOURNAL for January, 1917, reprints of which are obtainable from the JOURNAL office.

III. ORTHOPÆDIC OPERATIVE, POST OPERATIVE, AND ADJUVANT TECHNIC.

III, 7.

WAR SURGERY OF THE WRIST. Combier and Murard. *Revue de Chir.*, Vol. 37, Nos. 1 and 2.

This study is based upon the author's personal observation of 27 wounds of the wrist. In order to classify various types of wounds of the wrist joint, distinction is made as follows:

1. Wounds of the wrist without bone lesions.
2. Osseous lesions limited to one bone of the carpus.
3. Osseous lesions involving several bones.
4. Lesions of the carpal joints.
5. Lesions of the radio carpal joints.
6. Isolated fractures of the radial epiphysis without lesion of the wrist.

1. Wounds of the wrists without bone lesions are found in tangential wounds, often from small projectiles, which penetrate with little force and are arrested within the capsule. The ideal treatment consists in suture of the synovia after lavage. The open tendon sheaths are carefully restored and the tendons re-united. The authors often observed hematoma in the tendon sheath. In this case they prefer to incise the hematoma so as to avoid infection.

2. In joint wounds limited to one bone of the carpus it is possible to make the surgical interference very conservative, by removing the debris and curetting the surface and, after lavage with ether, closing the capsule. This conservative procedure was carried out in one case where partial dissection of the semi-lunar bone was made, with splendid results.

The conservative method is of greatest importance when dealing with the second row of carpal bones, especially the trapezium and unciform bone. In one case the author was able to preserve the trapezium and with it the stability of the thumb.

More often, however, fracture of one of the carpal bones will lead to extraction of the bone involved, and for this reason it is interesting to know the orthopædic value of isolated resection of the carpal bones.

Regarding the proximal row of bones, extraction of the scaphoid was done in a number of cases.

After resection in one case slight deviation of the hand outward was noticed, but otherwise the functional result was good, notwithstanding the fact that the scaphoid is of considerable indirect importance for the action of the thumb. The removal of the semilunar bone has likewise given good functional results, although some observers dispute its advisability and even prefer total resection of the wrist. This latter point, however, might apply more to old dislocations in which there are secondary modifications of the

carpus. The triquetrum, being only a superstructure of the wrist, might also be removed without great functional disturbance, and likewise the pisiform bone, as this is merely a sesamoid bone of the flexor carpi ulnaris.

Isolated resections of the distal row of carpal bones are more frequent than those of the proximal row. There are often accompanying fractures of the metacarpal bones. The trapezium was removed in one case, and, in spite of its importance for the stability of the thumb movement, the latter was found to be preserved, although limited and slightly painful.

In one case the trapezoid was resected with very good functional result. The removal of the os magnum, although of more serious consequence than that of the others, has given good results in one case reported. The condition two months after operation was as follows:

Extension was incomplete except that of the thumb. Flexion was also incomplete but rapidly improving. First and second interossei not acting. Movement of the wrist: Extension and flexion almost normal, as are lateral motions and pro and supination.

Of isolated removal of the unciform bone one case is reported. The removal of this bone involves the motility of the fourth and fifth fingers. Based upon this experience it is safe to conclude that isolated removal of carpal bones is a very promising procedure, attended by good results, especially in cases of removal of the scaphoid and semilunar bone, which are more frequent than any other. There is, however, every reason to believe the removal of any other bone of the carpus will yield equally satisfactory results.

3. Multiple Osseous Lesions. Ollier advised in multiple osseous lesion to perform a simple resection of the bone fragment by opening the tract and removing the detached bone splinter. This resection of the fragment, however, seems to the author an insufficient procedure today, when the walls of the wound appear to be so frequently infected and when the mechanical disinfection must be thorough and methodical. The author prefers in these cases, the arthrotomy, which is a more systematic procedure and much surer of results. Where circumstances permit, an immediate closure with drainage follows arthrotomy and careful dissection of the bone. Nevertheless, in two cases extraction of the splinters was performed with only moderate result.

Partial resection of the wrist was carried out in the proximal row of carpals by simultaneous resection of the scaphoid and semilunar. In one case the end result was, six months after operation, only moderate. There was only little power in the wrist and flexion-extension movement was incomplete. The radiographic study of these cases shows deviation of the hand radially. For this and other reasons the authors believe it preferable to combine the removal of the scaphoid with that of the semilunar and triquetrum, that is, practically the entire proximal row of carpals.

There was no partial resection performed on the distal row, but it is undoubtedly a very difficult procedure and should rather be substituted by total resection of the carpus.

The total resection of the carpus was performed for multiple fracture of the bones of the wrist. From the orthopædic viewpoint the results of carpectomy are quite satisfactory.

Regarding technic, the wrist should be approached by dorsal incision following outer border of the extensor indicis. In this resection the trapezoid is very important and should be saved, first, because it is very difficult to reach, and secondly, because it is very important for the motion of the first metacarpal bone. Likewise the pisiform bone may be left without inconvenience, and it is also preferable to leave the apophysis of the unciform bone for the reason that it is a point attachment for the anterior annular ligament

of the wrist. In regard to mobilization after operation, it is pointed out by the authors that this should be carried out in two phases. The mobilization of the fingers constitutes the first phase and should be carried out as quickly as possible, the fixation apparatus applied at operation leaving the finger free for this purpose. Later, mobilization of the wrist should be undertaken, which must be carried out for a length of time, and a palmar splint reaching beyond the basal phalanx should be worn between treatments.

Results. Results are evidently inferior to those of resection for closed fractures. This is due to many other intervening factors which determine ultimately function of the wrist, such as wounds of the soft parts, especially tendon sheaths, and of the nerve and blood supply.

In spite of these factors, results are, while moderate, still vastly superior to those of amputation and disarticulation. In three cases in which total resection was performed, results were as follows:

In one case, ankylosis and slight mobilization, giving the arm good functional use, after one year.

In the second case, movable wrist, with good function after 14 months.

In the third case, complete ankylosis, after 14 months, with good functional use of the wrist.

Ankylosis seems to be the most frequent outcome of total resection. It is entirely compatible with the use of the arm in a good many cases. Partial ankylosis is especially favorable. Ollier points out that in extension and flexion an amplitude of 40 or 45 degrees is sufficient and that one can play the piano with motility at 25 degrees. The most important point is lateral stability.

4. Carpo-Metacarpal Lesions. Metacarpal lesions very frequently accompany wounds of the wrist joint. In one group of cases there are injuries of the base of the metacarpal co-existing with partial fractures of the distal row. It is of the greatest importance to preserve the base of the metacarpal for the sake of the architecture of the hand as well as of the attachments of the interossei muscles. Results of partial resection of the metacarpal bases are unsatisfactory for several reasons: First, on account of the mechanical disturbance of the palmar arch formed by the metatarsal, then also on account of the interference with the insertion of the interossei. The outcome of these resections is much inferior to that of carpectomy, and the movement of the fingers is almost *nil*. If one is obliged to resect the metacarpal bone, the corresponding finger should also be disarticulated. If resection of several metacarpals is necessary it is often better to perform disarticulation of the wrist.

5. Carpo Ante-brachial Lesions. In total fractures of the carpus and the epiphysis of the forearm the resection of the wrist combined with that of the forearm epiphyses, while giving less satisfactory results than carpectomy, is surely more promising than resection of the carpo-metacarpus.

The greatest disadvantage is the shortening of the skeleton and with it the relaxation of the extensor tendons. The latter point is taken care of by shortening of the tendons. In partial fractures of the carpus and of the epiphyses of the forearm, an economic resection might be done.

6. Fracture of the Epiphysis of the Forearm without Lesion of the Carpus. The procedure in these cases consisted in resection of the forearm fragment without touching the wrist. The epiphysis might be taken care of by separate incision on both sides of the forearm. A case of fracture of the epiphysis of the radius was operated by the authors, with the result that two and one-half months later the patient had complete range of motion in flexion and lateral abduction, though extension was still somewhat limited.

In infected wounds of the wrist the surgical procedures depend very much upon the extent and nature of the infections. Non-virulent, or limited, infections are observed in wounds on the third and fourth day following insufficient primary intervention. These cases do not require treatment essentially different from the one already mentioned.

In cases of suppurative arthritis, however, the conditions are vastly different. This infection is not at all limited to joints, but involves also the synovial sheaths, the tendons and soft structures, and, possibly, bones of the forearm. Among four cases of the latter group amputation was performed in one. In three cases resection of the carpus was performed on the third twenty-third and twenty-eighth day after injury. Comparatively good results were obtained in the latter three cases, and healing took place, in one case, after three months, and in another case, after six months.—*Arthur Steindler, Iowa City.*

III, 7.

Surgery at Front Hospital. Pool, Lee, Dineen. *Surg., Gyn. and Obst* Sept., 1918.

In a 22 page article the authors cover their winter's experiences with Colonel Depage at La Panne. This abstract covers only the orthopædic portions of their paper.

Fractures divide into compound fractures caused by projectiles; compound fractures caused by accident, and simple fractures.

Compound fractures caused by projectiles necessitate the same surgical technique for the wound as if there were no fracture. If the projectile passes to the bone, the fracture should be exposed freely, fragments detached from periosteum removed, viable pieces left *in situ*. Free irrigation with salt solution removes small dirt particles. If the bone has been fractured through transmitted shock and is not exposed to the wound, do not expose. Wounds sterilized with Carrel-Dakin solution, and delayed primary or secondary closure made. Osteomyelitis is favored by a closed infected wound. It is inadvisable to use plates or wire in an infected wound, as osteomyelitis may result.

Apparatus for compound fractures. Perfect reduction, immobilization, accessibility to the wound and comfort are striven for. Frequent X-ray examinations are necessary Sinclair aims to employ sufficient traction to elongate the limb, replacing most of the fragments, correcting abnormal position of nerves, blood vessels and lymphatics, and favoring repair. For upper arm and shoulder fractures, suspending with hammock from Sinclair rod, abducted, straight elbow position, traction on forearm, allows of accessibility and gives fair immobilization. Thomas and Blake splints are also uesd; cock-up splints for wrist, hand and fingers. For the upper third of the femur no thoroughly satisfactory method seems to have been devised Thomas, Hodgen and Sinclair splints are used. Weight and pulley with overhead counter traction is freely used for fractures lower down. Compound fractures caused by accident are treated similarly.

Simple fractures are treated as in civil practice.

Wounds of joints. (1) Good surgical technique; (2) Careful radioscopy and radiography; (3) during operation every possible means of exact foreign body localization; (4) most painstaking soft tissue dissection so that surgeon does not open spaces that are not opened by the projectile; (5) the joint must not be opened without satisfactory demonstration of a wound of entry. Incisions made directly over the foreign body. (6) Complete excision

of all soiled, lacerated tissues and removal of all foreign bodies; (7) irrigation of joint with saline and flushing with ether; (8) complete primary suture is vitally important in joint surgery; (9) early active joint movement prohibits formation of fibrous bands, aids in the expulsion of blood clots. Immediate mobilization may be delayed 5 or 6 days if there has been considerable loss of muscle tissue overlaying an extensive bony lesion.

In wounds without injury of bone or with little injury of soft parts or bone, the incision of approach to the joint must be determined by the situation of the skin wound of entrance and exit or by the position of the foreign body itself. After careful removal of soiled injured tissues, foreign bodies, irrigation of wound, it is immediately closed in layers Active mobilization of the joint is begun the following day, 3 to 4 times daily, at least once at night. This is very painful at first, less so later. Walking is started the day following operation, if possible, in lower extremity cases, dusting, etc., for upper extremity cases.

A new method of treating acute purulent arthritis has lately been employed. The knee or elbow is usually opened laterally, use no drainage material, employ no irrigations, change hot moist dressings every two hours for 48 to 72 hours, active movement of the joint every 2 hours, waken the patient 2--3 times a night. It is maintained that the joint will drain itself if active movements are kept up. The patients are quite uncomfortable during the early weeks.

Wounds of the hand and foot are frequent; the watchwords are conservation of tissue, primary suture and early passive motion.—*Leo C. Donnelly, Detroit.*

III, 7 and XV, 1.

Surgical Consideration of Peripheral Nerve Injuries. Byron Stookey *Surg., Gyn. and Obstet.* Oct., 1918.

In war injuries, nerve suture can be done only in a sterile field, hence nerve suturing must be done in secondary operations. It is impossible to determine without waiting for nerve degeneration to manifest itself, to state whether a nerve will regenerate without operative interference. 40 to 60 per cent. recover without interference; interference might have shortened convalescence. So long as there are progressive signs of nerve regeneration, as formication, shrinkage of areas of anaesthesia, return of deep sensibility, return of muscle tone and sensibility, operation should be postponed. Formication is elicited by gentle pressure on the nerve trunk, producing a peculiar creeping sensation referred to the peripheral distribution of the nerve When signs of nerve regeneration cease to progress or do not appear, then operation is indicated. Three to four months should be waited for their appearance.

Nerve operations are operations of choice, being done only where ample facilities are present and after thorough study. Under general anaesthesia a dry field without the use of a tourniquet is prepared by free hemostasis, bleeding from nerve ends controlled by prolonged digital pressure, bits of torn muscle held in apposition, etc. Trace the nerve through scar tissue by following from the healthy part from above down, and below up. Cut only partially through scar nerve, using the scar to help hold ends together and to prevent axial rotation. End to end apposition is desired. Small, smooth, round, half curved needles with either fine silk or plain catgut are used The suture includes as little nerve as possible.

There are three main types of operation: neurolysis or nerve liberation; suture, partial or complete; and nerve grafting. Nerve liberation is suc-

cessful only when the nerve has been completely freed and there is no scar tissue present in the nerve. If there is only a very small amount of scar tissue present the injections under pressure of sterile salt solution may open up paths for the neuraxes; if there is considerable scar, resect and suture.

Direct nerve suture should be done only when the nerve ends can be brought in apposition without tension. Gentle traction may be used; altering the position of the limb aids. Suturing under tension fails because it means an increase of scar tissue.

In excising scar make consecutive thin sections until normal nerve appears, then only can plan of nerve bridging be considered. In partial nerve suture one removes the scar tissue without injuring the normal nerve funiculi. The radial below the elbow, musculo-cutaneous of the arm or leg, can be used as grafts. The nerve should be loosely surrounded with a fat pedicle or buried in muscle or placed between muscle bellies. Tendon transplantation may obviate the necessity of nerve suture. When nerve injuries are associated with aneurism the prognosis for successful interference is poor.—*Leo C. Donnelly, Detroit.*

V, 2, a.

V. TUBERCULOSIS.

Diagnosis and Treatment of Tuberculous Arthritis of the Hip Joint. H. W. Meyerding. *Minn. Med.*, Aug., 1918.

He gives a very good table of differential diagnosis

1. Traumatic arthritis or periarticular injury is differentiated by local tenderness, ecchymosis, history, negative x-ray, while impaction fractures later cause limp, and shortening due to loosening of the impaction, positive X-ray.

2. Chronic hypertrophic arthritis appears in older people and shows characteristic lipping without rarefaction. The limitation of motion is usually in abduction and rotation and there is little or no muscle spasm, shortening etc.

3. Infectious arthritis is usually multiple, acute, accompanied by high fever and leucocytosis. Removal of local infection leads to rapid recovery Aspiration and bacterial examination aid in differential diagnosis.

4. Perthes' disease, osteochondritis deformans juvenilis, may be differentiated by characteristic epiphyseal changes.

5. Infantile paralysis is easily differentiated in the paralytic stage, in the acute stage there may be local pain and tenderness for a short time.

6 Arthritis of the knee allows motion of the hip without pain, when the knee is immobilized and whole leg carefully manipulated.

7. Pott's disease of the lumbar spine has as its earliest symptom muscle rigidity. Careful manipulation of the hip with negative X-ray rule out hip.

8. Congenital dislocation lacks muscle spasm, rigidity, atrophy, etc., and is positively diagnosed by the gait, palpation, and X-ray.

As to treatment, sunshine, fresh air, simple substantial food, are preferable to medicine. Local treatment dependent on the stage of the disease and the circumstances. He prefers Jones abduction frame which allows of fixation and extension, relieves pain and spasm and corrects deformity.

The patient remains on the frame until acute symptoms subside, general condition improves, deformity is corrected and there is a redisposition of lime salts. During the subacute stage, if no drainage exists, the patient may be up in a cast of Lorenz type, the well leg raised with high heel.

Patients in subacute or chronic stage have deformity corrected by brisement forcé or Gant osteotomy.—*Leo C. Donnelly, Detroit.*

Vol. I, No. 3 MARCH, 1919 Old Series. Vol. xvii, No. 3

The Journal *of* Orthopædic Surgery

DISCUSSION OF THE INDICATIONS, TECHNIQUE AND RESULTS OF TRANSPLANTATION IN GUNSHOT INJURIES OF NERVES.

BY MAJOR T. P. McMURRAY, LIVERPOOL.

Mr. President and Gentlemen:

The subject of tendon transplantation in nerve injuries is an immense one, and, moreover, it is one which is growing in importance every day and we are seeing, more and more, cases in which this method of procedure is applicable. At first we thought—and most of us were taught,—that every suture of a nerve we could accomplish would be followed by complete recovery; we thought we should see the function coming back in the limb. And then we began to find that in numbers of cases after three or four years there was no recovery of function. We did not know the reason of that failure; we had got the suture accomplished, as we thought, successfully, and we had felt certain there ought to have been recovery. But this kind of case is coming back day after day, and bringing a tremendous amount of work, and so the question of nerve suture has to be squarely faced. Another type of case is that in which at the operation there is no possibility of bringing about end-to-end suture. The percentage of cases in which the result is unsatisfactory varies according to the particular nerve injured. In the case of such a nerve as the median, the number, or the proportion, in which end-to-end suture cannot be achieved is very small. If you have a case in which the median nerve in the arm is injured at the bend of the elbow, flexion of that elbow will fill in a gap of three inches. In the case of musculo-spiral injury, you find that with flexion and adduction of the arm there are at least 5% in which it is impossible to get anything like end-to-end apposition. I have had

about ten cases in which it has been impossible to get this apposition, and I have tried various methods of filling in the gap in the nerve. The first method was by taking a cutaneous nerve which was of less importance and implanting it between the divided ends. Secondly, we took a tube of fat and put the end of the nerve in this tube of fat and then a tube of fascia round that. But none of those, I am sorry to say, has been successful. I have watched these cases for over a year after I have carried this out, but in no case, after a year, or even 18 months, has there been a sign of recovery. That class of case, obviously, should have something else done. If we know the prognosis is so bad that there is practically no hope of recovery of the nerve by any means which does not include end-to-end suture, we realize that something else should be done at once.

Then we have those cases which, with the nerve destruction, have also a lot of muscle loss. We frequently find, in cases of gunshot wound of the back of the forearm, in which the posterior interosseous, or the lower part of the musculospiral is injured, that in addition the upper part of the muscles of the forearm have been shot away. No nerve suture, in such a case as that, would be of advantage, even though the nerves were capable of being brought into apposition; there is no muscle to carry out the function.

The tendon transplantations which can be done with advantage vary very greatly according to the nerves involved. If we take these tendon transplantations in turn, we find that the nerve most frequently injured is the musculo-spiral which may be injured in any of its parts. It is most frequently hurt at the back of the humerus, in association with a compound fracture of that bone. In such a case you may get a nerve which has laid there for one or two years after a compound fracture; the nerve has been lying in the midst of sepsis, without any attempt at suture having been made, or perhaps being possible, for a year. Even though, in such cases, we may get end-to-end apposition, the nerve is unlikely to recover. We find a septic compound fracture of the humerus, with a discharging wound, and then, at the time of the operation, we find that nothing can be done to suture the nerve, because of the loss of tissue. Then tendon transplantation holds out the only hope for recovery of function in the arm.

Consider the muscles which can be transplanted in the forearm. On the front, there is the flexor carpi radialis and the flexor carpi ulnaris. These have only one action, that is, flexion of the wrist with the fingers extended. Consider how often in flexion of the wrist the muscles I have named can be done without. Sherrington showed us that with any

action of a group of muscles producing a given movement of a joint, you have a reflex inhibition of other muscles. In extension of the wrist there is a reflex inhibition of the muscles which produce flexion. Therefore every time the wrist is extended by the extensor carpi radialis the flexors are thrown out of action by inhibition from the nerve centre. The only position of strength for the hand is with the hand dorsi-flexed. That is the position for withstanding strain, and when that position is taken up, we realize how one of the muscles can be done without. Then there are the pronators and supinators. Let us take the pronator radii teres. It is possible to pronate without the pronator radii teres; you equalize the two groups much better by doing without it; in spastic hemiplegia the arm is held in a position of fixed pronation, and the only way to get supination is by division of the pronator radii teres. We know that division of this is not followed by weakness, and therefore we can do without it. Here then are three muscles which can be done without. The only other muscle which can be done without is the palmaris longus. In at least one out of ten cases that muscle is not present; it is a very variable muscle; sometimes it is present and strong, sometimes it is absent. Wherever it is present, it may be used for transplantation. So there are four muscles which can be done without, but one of them is unreliable. The other three can be dispensed with without loss of power.

Now with regard to the technique of tendon transplantation in cases of the musculo-spiral nerve injury. We are going to transplant into the dorsal aspect to produce two things, dorsi-flexion of the wrist, and extension of the fingers. It is not enough to have only extension of the fingers, you must have with it, extension of the wrist. The only tendon which can be used to produce that dorsi-flexion of the wrist properly is the pronator radii teres. Various other operations have been devised but none of them will produce dorsi-flexion. As we know, the pronator radii teres will produce it. The pronator radii teres is inserted into the middle of the shaft of the radius, just under cover of the supinator longus. It is not inserted in the ordinary way. It does not become progressively narrower, it is a broad flat tendon, and is inserted by a broad base into the outer surface of the radius. The tendon is only about half an inch in length, and if it is to be raised up from the radius, it must be taken up completely, because part of the muscle is of no use at all; you must have the whole. And you cannot take that muscle completely away without taking also its periosteum. The incision which we employ is the long J-shaped incision along the radial border, parallel to the supinator longus, curving round over the back of the

wrist joint, and curving up on the inner border of the forearm for three inches. Its upper border on the radial side extends just above the insertion of the pronator radii teres. The full flap is turned back. I have never seen such a flap slough, not even at the edge, nor has it caused trouble. The pronator radii teres is taken off the radius, with its periosteum. And here I might mention that we have taken a series of X-ray pictures a year after operation, and not one case has shown a bony deposit in the periosteum. So the trouble of there being a subsequent bony deposit does not seem to come into the scope of the operation at all. If the extensor carpi radialis longior alone is acting, unless you insert the radii teres into both the extensor radialis brevior and longior, you cannot have true extension of the wrist; it must pass through and act on both muscles.

Further down, we take the flexor carpi radialis from its insertion as low down as possible, and the flexor carpi ulnaris as low as we can, too. In the flexor carpi radialis you have a long, thin tendon five inches in length; in the flexor carpi ulnaris you have a tendon 1½ to 2 inches in length in its upper surface, and ¾ inch on its deep surface. These two tendons are taken and brought round to the dorsal aspect. It is easy, after dividing the flexor carpi radialis, to bring this tendon to the dorsal aspect. If you try to bring the ulnaris round by only dividing its insertion, you find it is adhering to the inner border of the ulna by muscle fibres, therefore you must divide that attachment for three inches from its insertion. This is the only way you can produce a straight line from the origin to the insertion of the newly transplanted tendon. The whole secret in connection with tendon transplantation in the forearm is the avoidance of angling of the tendons, just as it is the secret of tendon transplantation anywhere else. If you make small incisions and do not deal with the whole course of the tendon, you are almost certain to have angling of the tendon, which, as I say, is what we have to be careful to avoid. If such angling results you are not likely to have success. A transplanted tendon will not work round a hook of bone, or fascia; it must take a straight line from origin to insertion. It is for that reason that the long incision has been advocated. These two tendons, then, are brought round to the dorsal aspect of the forearm and brought obliquely. The flexor carpi radialis is inserted into the two extensors of the thumb and the extensor of the index finger. There are three extensors of the thumb. The extensor longus pollicis is not essential. You will find in musculo-spiral nerve paralysis that the patient can straighten out the end of his thumb; this is not due to the action of the extensor longus muscle, it is due to the muscles of the

thenar eminence, therefore it is associated with adduction. We find that the thumb and index finger always work together in the normal movements of the hand. And if we arrange for extension of the thumb and of the index finger to be carried out by one transplanted tendon, and extension of the other fingers to be carried out by the other, you will find the result satisfactory. This is the best grouping for purposes of function. After those tendons have been brought round to the dorsal aspect, they can be inserted into the extensors in three different ways. The first way is to split the tendon, and pass one half under the receiving tendon, and the other half above it. The two ends are joined beyond the receiving tendon, and each half of the transplanted tendons sutured to the receiving tendon. That leaves one raw surface above, and one below. And in order to produce a strong union you must make the surface of the receiving tendon raw, because a raw surface on a tendon is the only way to get it to unite. If two raw surfaces are brought together, they unite and become strong, whereas two shiny surfaces will not unite; they will show a marked tendency to slide. The second method of transplantation is to take the three receiving tendons, and divide them from their muscles, leaving the three ends free. Pass these three ends through the transplanted tendon at different levels, and bury their ends in this. The third method, which is not so good, is to split the transplanted tendon into three, and insert one of each of the three divisions into one of each of the three receiving tendons. I say that this method is not so good, and I say so because it is so liable to cause adhesions as compared with the other methods. In this case, you see, you are leaving three or four raw surfaces open. It is the same with the flexor carpi ulnaris. This tendon is very small but strong, and if you split that tendon and pass it round one half on either side of the receiving tendons and join the bare ends together, you can easily suture these three receiving tendons to the raw surface of the transplanted tendon. When that is done, you will find there is no necessity to wrap any fascia, or fat, or mucous membrane round any of those junctions, if the simple expedient of covering in the raw ends of the transplanted tendons is adhered to. But if you leave raw surfaces, you will get adhesions. The line of suture is then closed up with two layers; first deep fascia, then skin. After closure of the wound, the patient is left with the wrist and fingers in the dorsi-flexed position. The fingers are never left hyper-extended. Most of these injured hands, such as are seen so often in hospitals and which have taken so many months to cure, have been put on flat splints, with the palm spread out and the fingers

hyper-extended. It is found that it takes months to bend those fingers, because they have been so long in a position of hyper-extension. The way in which a dorsi-flexion wrist splint should be put on is with the fingers in slight flexion, that is to say about 10 degrees of flexion at each joint, the metacarpo-phalangeal joint at 10°, and so on, each with slight flexion. There will be no stiffness if you take care to keep that position. But there certainly will be stiffness if the hand is forced out with the fingers hyper-extended. Of all the transplantations of tendons in any part of the body, that for musculo-spiral paralysis is the most successful. This is because the three tendons which we use are always constant and always strong. There is, of course, no use in transplanting a tendon which is not capable of doing work, that is to say, one which will not do the particular work you want it to do. Therefore the median and ulnar muscles must be strong before you even suggest transplanting. There must be complete control of the flexor aspect of the forearm before you try to get control of the extensor aspect. I have myself done 25 of these cases of musculo-spiral paralysis, and in not one of them has the man been unable to go back to his work. One of the patients, who was a private, has now got a commission. Nine months after the operation was done he passed the full gymnastic course, and he has now been out in France a year, and has been wounded slightly. That will indicate sufficiently that the hand he got after the operation was a useful one; it was the right hand, and he was perfectly able to do all his normal work, as before. We have got, downstairs, two cases, and presently you will be able to see what they look like. You will see that the men can close the fist, extend the fingers, dorsi-flex the wrist, and that extension is not passive but active.

The next nerve lesion to be considered is complete destruction of the ulnar. We know that frequently, the ulnar is destroyed over a long part of its course, and usually this is accompanied with a badly comminuted condition of the internal condyle of the humerus. If we transplant that ulnar nerve in front of the internal condyle, we can close in a gap of at least four inches. If there is a bigger distance than that, it is impossible to close in the gap without dividing the nerve to the flexor carpi ulnaris and the deeper part of the flexor profundus. You frequently come to a point, by flexion of the wrist, at which you cannot pull the ulnar nerve any more without dividing these two little branches. Then the question is whether you will sacrifice the muscles of the hand. Can you hope to get the muscles of the hand back by transplantation, or will you have to sacrifice two branches of the nerve? You frequently find yourself up against this point, and you have to come

to a decision. You must sacrifice either the muscles of the forearm or the muscles of the hand. If there is a mobile hand, it is best to leave the flexor carpi ulnaris and the flexor profundus, because when the ulnar nerve is destroyed it may leave a very good hand, in fact it does so in the majority of cases. With that treatment you are able to get a mobile hand, without, perhaps, as much strength as before, but far better than would have resulted if you had destroyed the ulnar profundus nerve supply. The ulnar nerve is sometimes found to have gone entirely; far up, the branches to the flexor carpi ulnaris and the flexor profundus are also gone, and it is impossible to get the two ends together. Then arises the question whether anything can be done for the patients with this condition. Very little can be done for them, but very little is necessary in cases of ulnar nerve paralysis. In at least 75% of these cases the patient has a hand which is perfectly useful, and nothing operative is needed; the man can do his normal work, and can get through that normal work perfectly well. But in some of the cases there is complete loss of flexion of the little finger, and in some there is also complete loss of power to flex the ring finger. In these cases, a long straight incision is made along the flexor aspect of the forearm. You first come on the flexor sublimis. That is pulled in, and you get down to the flexor profundus. Then you find the two outer tendons of the flexor profundus which are innervated by the median nerve, and the two inner which are innervated by the ulnar nerve; and it is the simplest thing to suture the two inactive tendons to the two outer active ones. Then you have the outer part of the flexor profundus, which is supplied entirely by the median nerve, acting on the inner part, which was inactive before. That, as far as tendon transplantation goes, is as much as we can do in ulnar paralysis.

Now with regard to median paralysis. Complete destruction of the median nerve is a rare event, that is to say, destruction so bad that we cannot get the end-to-end apposition that we want. But a median nerve paralysis which has existed as long as 2½ and even 3 years without recovery is not rare. We know that at the Pensioners' Outpatient department we get a lot of pensioners, dozens of cases, in which function of nerves has not come back after they have been sutured 18 months or two years. In a lot of those cases the nerve injured is the median. I am not yet able to speak definitely of the statistics, because they are in the making. The suture of the nerve seems to have been successfully done two or three years ago, but there has been no recovery.

We get, in these cases, a hand which is very much worse than in cases of ulnar paralysis. The thumb is useless, it will not flex, except that it can, perhaps, be adducted into the palm by the flexor brevis pollicis, with closure of the ring and little fingers, but usually no movement in the index finger. There may be trophic changes, but this is not common; there may be blueness, but not ulceration. In the median nerve cases, we can transplant one of the active extensors of the wrist, and the best of these to select for the purpose is the extensor carpi radialis longior. On the radial side of the wrist joint there are two extensors of the carpus. They both act in the same way, and one can be done without. Through an incision on the outer side, you can get at both the flexor longus pollicis tendon and the extensor carpi radialis longior tendon. The extensor carpi radialis longior is divided at the base of the second metacarpal, and it is brought forward under the supinator longus, or over it, whichever you please, to the anterior aspect of the forearm, and then is implanted into the flexor longus pollicis. Here we have two tendons which are practically the same size, and the problem is a totally different one from that of the insertion of the flexor carpi radialis and ulnaris in museulo-spiral cases. As these two tendons are practically equal, you should be able to make a suture which will leave the tendon edges quite smooth, without thickening or abruptness. And the best implantation here of one tendon into the other is the lateral implantation. By this transplantation you get a tendon which will act on the thumb and take the place of the flexor longus pollicis and it will act well, too. After such a procedure as this the thumb becomes a very useful member, which can be approximated to each of the other fingers.

Let us now take the shoulder joint. We find paralysis of the deltoid if the museulo-spiral is divided high up at its origin with the circumflex nerve; there is that paralysis in addition to complete paralysis of the extensors of arm and forearm. Here you have the shoulder joint completely paralysed, and you, naturally, try to suture your circumflex nerve, or suture the trunk at a place before the circumflex nerve comes off. If that proves to be impossible, you think of tendon transplantation. Tendon transplantation for this condition was done, of course, long before the war. Part of the trapezius was displaced from the clavicular and acromion, and attached over these to the deltoid. But none of the cases so treated was successful. The arms were useful when supported by splints, but that was all; there was no movement in the transplanted muscle, and there was never active abduction of the shoulder. So tendon transplantation in the case of paralysis of the

deltoid does not rank as a useful procedure. The best treatment is an arthrodesis of the shoulder. There is an active trapezius, and after arthrodesis all the muscles governing the scapula govern the upper arm.

We now come to the nerves of the lower limb. The first is the anterior crural. Cases of injury to this nerve we sometimes see in an orthopaedic hospital, but not very often, because the anterior crural nerve lies so close to the femoral artery and femoral vein, that any injury to it is likely to be accompanied by a bad injury to either the femoral artery or the femoral vein, and so to be accompanied by a fatal haemorrhage. We see a few cases in which there is paralysis of the quadriceps, usually partial. Of at least a dozen such cases I have seen, ten have recovered by rest, massage and electrical treatment, though at first they were, apparently, completely paralysed. The nerve could not have been completely divided. If there be a complete paralysis, it is necessary to do tendon transplantation in order to produce extension of the leg on the thigh. There are various muscles on the posterior aspect of the thigh, the strongest of them being the biceps. The biceps can be used by itself, or in combination with one of the muscles on the inner side of the thigh. The semitendinosus and gracilis can be used either alone, or both together. You should never use the semimembranosus for this purpose, because of its close association with the knee joint. The biceps is taken by a long incision over the course of the muscle down to its insertion into the head of the fibula. You must see that the line you get is a straight one; there must be a straight tendon between origin and incision. So you make your incision at least twelve inches long, from the head of the fibula upwards, completely freeing the biceps from its capsule, and separating the lower half of its deep head from its origin from the external supra-condylar ridge of the femur. Take the tendon forward, and bring it through a small hole above the patella. It is then sutured into a groove in the patella, made with a chisel. The best way is to make a definite groove in the bone and lay the tendon in it, then completely close. If you use the biceps alone, it will give you extension of the leg, but it will also give you an outward pull on the patella, so you will then have a tendency to knock-knee, and there will be a liability for you to get a displacement outwards. It is better to use one of the muscles of the inner side to equalize the pull, and so pull the patella straight up. It is better to do that through a similar, or the same, incision. The semitendinosus is brought round the inner side, and sutured to the patella, in the same way, into a groove. Thus you have the biceps and the semitendinosus both producing extension of the leg on the thigh. The knee is kept straight for four to six

weeks, and you can use massage and electric treatment on the transplanted muscles, as soon as the stitches are taken out. In this way you get active movement, and gradually increasing active flexion starting after six weeks. Forced passive movements must not be given.

Next we come to the great sciatic, and its two branches. The external popliteal is frequently injured, and the site of such injury is, often near the head of the fibula. But by flexion of the knee joint you can bring the ends together, and usually you can get complete restoration of function. The prognosis after suture to the external popliteal is very good: in that respect it is like the musculo-spiral. Now, if there is no recovery in the external popliteal muscles, there is, as a result, a completely dropped foot. Here you need to produce not so much movement as strength. The first condition to be looked for in the lower limb is strength, whereas in the upper limb the desideratum is active movement. We can take any of the extensor muscles of the foot, on the anterior aspect of the leg, and attach their tendons to the tibia, so as to produce a foot which is held at a right angle, or slightly more. The usual muscles taken for this purpose are the tibialis anticus, and one of the peronei. If one of the peronei is pulled upon while it is behind the fibula, you will find that there it plantar flexes the foot. If you transplant it in front of the fibula, and pull, it no longer plantar flexes the foot but it still everts the foot by 15°. If you use the peroneus longus and tibialis anticus you slightly dorsi-flex the foot. These are not the best muscles to use. The peroneus brevis will evert the foot and hold it at right angles, whereas the peroneus tertius will evert the foot and dorsi-flex it; and if the peroneus tertius were strong enough, it would be the best muscle, but it is not. We know, of course, that these muscles which are transplanted show a tendency to stretch afterwards, therefore it is necessary to use the strongest tendons possible. And the best of all tendon fixations in the leg result from the use of the tibialis anticus and the peroneus brevis. The tibialis anticus is taken four inches above the ankle joint, just to the outer side of the anterior border of the tibia. Make a vertical incision and get down on the tendon, lift the periosteum from the bone, drill a hole through the bone into the medullary cavity from either side, and cut off your tendon about two inches above that hole. The hole should be two inches above the ankle joint, above the annular ligament. Put the lower end of the tendon through the hole, turn it back on itself, and suture it. In this way you have a loop of tendon passing through the bone. We know that this is a far better method of fixation than putting the tendon into a groove. The other way is by making a groove

in the bone and laying the tendon in it, and fixing it in that way to the periosteum. In the case of the peroneus longus or peroneus brevis muscle, you take it four inches above the lower end of the fibula, through an incision made over it. The tendon is divided through this upper incision, and is pulled through a lower incision, being then brought up alongside the tibialis anticus, underneath the anterior annular ligament, because this will leave a tendon which is held down in position, and which does not stand out. If you transplant the peroneus brevis and pull it tight across the ankle, you leave a tendon which stands out underneath the skin, and so is liable to irritation by the boot in walking. It is better to transplant the tendon underneath the annular ligament. You can fix it through the same hole in the tibia which has been already bored. In adults the hole which you have to bore is a big one if you transplant two tendons through it. It is, therefore, better to take the tendon through a new hole lower down, and transplant it in the opposite direction. You suture the peroneus longus to itself. If you wish you can join the upper end of the tibialis anticus to the course of the attached lower end, below the insertion into the tibia, so that if there is any recovery of function in your muscle, it will still act and dorsi-flex the foot. But you should not attempt tendon transplantation if you think there is a chance of recovery without it.

Internal popliteal paralysis can be treated in many ways. The way usually followed in children's hospitals is to supply a metal tongue to the boot, which will not allow dorsi-flexion, so that such a patient walks with that foot at right angles. If you can fix the foot at right angles it is better than obliging the patient to wear an instrument all the time. The best operation is to make an incision on the inner or outer border of the tendo Achillis, and fix this through a hole in the bone, in the same way as in the case of the tibialis anticus. In this case, you may leave half the tendo Achillis in its normal position, and transplant the other half and suture, holding the foot at right angles. And if you have, in the patient, recovery of function of the gastrocnemius and soleus, there is still plantar flexion action of the foot.

TENDON FIXATION IN IRRECOVERABLE MUSCULO-SPIRAL PARALYSIS.

BY A. ROCYN JONES, M.B., B.S., M.R.C.S.,

Acting Surgeon, the Royal National Orthopædic Hospital, London.

THE idea of converting paralysed tendons into ligaments for the fixation of joints seems to have been first conceived by Tilanus of

Amsterdam in 1898. In that year he published a paper on tendon transplantation and reported upon some seven cases of paralytic deformities of the foot, upon which he had performed the operation. In one of these cases he attempted a kind of fixation. The patient was a girl aged thirteen, suffering from paralytic talipes equino-varus upon whom Tilanus operated on January 25, 1898. He first cut the tendo Achillis subcutaneously and afterwards did an open tenotomy of the extensor proprius hallucis attaching the central end to the extensor longus digitorum, and the peripheral end to the periosteum of the tibia by means of a silk suture. He then put the foot up in plaster of Paris and reported that he obtained a good result. Codivilla, however, was the first definitely to advocate the operation of tendon fixation. He was struck by the manner in which tendons were sometimes embedded in callus in cases of fracture and proceeded with his pupil, Sangiorgi, in 1900, to attempt to produce a similar result for the fixation of flail joints. In conjunction with his pupil he lifted a flap of periosteum and prepared a groove in the bone to receive the tendon, which was sewn down under proper tension and the periosteum brought over.

In 1903 Reiner introduced what he called tenodesis. He threaded the tendon with silk from bone to bone, for example, in paralytic talipes varus, a strong silk thread was passed through the base of the fifth metatarsal bone and tied, the two ends were then pleated along the peroneus brevis, which had been cut and brought from its bed to the front of the fibula. Similarly, a second thread was fastened to the cuboid and its two ends guided, in and out, along the peroneus longus to the back of the fibula in which a hole was bored antero-posteriorly. These double threads were sent through the tunnel, thus prepared, in opposite directons and passed along a prepared groove on the outer surface of the bone and there tied.

In 1912, Gallie of Toronto adopted tendon fixation in paralytic deformities of the foot and three years later reported on a series of approximately one hundred cases with very gratifying results. Gallie incises the periosteum and, if an epiphysis be present, the perichondrium also. Periosteum and perichondrium are then raised on either side and a trough is gouged in the bone and cartilage. The foot is placed in the corrected position and the tautly drawn tendon is then laid in the groove, and a kangaroo tendon suture passed through cartilage and tendon and then tied, the tendon being firmly fastened. The periosteal edges are brought together with a catgut suture, the rest of the tendon being buried in the groove.

In partial paralysis with persistent deformity Gallie has also had

Fig. 1. The fixed dorsiflexed attitude of the carpus and metacarpus.

Fig. 2.—Grasping a wooden mallet.

Fig. 3.—Lifting and holding a gas cylinder weighing over eight pounds.

A Discharged Soldier upon Whom a Tendon Fixation Has Been Performed for Irreparable Musculo-spiral Paralysis.

excellent results, by using half the tendon for the fixation and leaving the rest to functionate normally. For example in calcaneus, he splits the tendo Achillis longitudinally and at the upper end of the incision, cuts free the anterior half and then fixes and buries it in the tibia, locking the foot at rightangles.

Hitherto, the operation of tendon fixation has been confined to the lower limbs, owing partly to the greater frequency of poliomyelitis in these extremities. It has, however, a peculiar value in dropped wrist following injury of the musculo-spiral nerve, where the nerve on exploration is found to be beyond repair.

In such cases the grasping power of the hand and fingers is rendered feeble by the complete loss of muscle balance, and unless the carpus and metacarpus are steadied by the radial and ulnar extensors a powerful handgrasp is impossible. But by converting these three extensors into ligaments the carpus can be fixed in the best functional attitude of dorsi-flexion, and still permit movement at the wrist joint, but not in the direction of the deformity.

In performing the operation good exposure of these tendons can be obtained by a single three and a half inch incision commencing just above the back of the wrist joint and extending up the middle of the forearm. By retracting the extensor ossis metacarpi pollicis and the extensor brevis pollicis, the two radial extensors can be followed along the forearm, and their tendons divided high up, the ends being pulled down. A tunnel of a sufficiently wide bore to accommodate these somewhat thick tendons is then drilled right across the radius from the outer side, a little over an inch above the line of the wrist joint. The tendons are next scarified with a knife the better to promote union with bone and periosteum, and the extensor carpi radialis longior is afterwards led through the tunnel from the outer and the brevior from the inner side.

The hand is held well dorsi-flexed, and each emerging end is drawn taut with artery forceps and made to overlap the other extensor to which it is sewn with a continuous catgut suture. One or two sutures should be passed through tendon and periosteum. In the same way the extensor carpi ulnaris is followed up the forearm, divided, and its end taken, from within outwards, through a tunnel in the ulna at the same level as the radial extensor. The end is drawn taut and any tendency towards radial deviation of the hand by the pull of the radial extensor is corrected. The emerging portion overlaps the other part of the tendon, the two being sewn together with catgut. The skin incision is closed with horse hair and hand and forearm encased in

plaster of Paris. It is important that the hand be supported in the dorsi-flexed position from the time the first catgut suture is inserted until the last plaster bandage is applied. The stitches are removed in two or three weeks and a fresh plaster cast put on.

The plaster is discarded in two or three months from the time of the operation and the patient allowed to use his hand, but a wage earning employment is inadvisable for another six weeks.

In one case operated upon the periosteum on the radius was incised and elevated and instead of a tunnel a groove was gouged along the bone to receive one of the tendons, but there does not appear to be any particular advantage in this and it takes much longer than boring a tunnel through the bone. It is important to keep the bony attachments of the tendons separate and not allow them to enter the same aperture. With the tendons fixed as described, there is very little deviation from their natural path and therefore they exert a straight and direct pull on the hand.

The first case operated upon was a pensioner who sustained a gunshot wound of the right arm in May, 1916. He was admitted fourteen months later, in July, 1917, to the Royal National Orthopaedic Hospital with an old comminuted fracture of the middle of the shaft of the humerus with loss of bone, the fragments having been united in good alignment. He had in addition complete musculo-spiral paralysis and his right arm was therefore explored. The musculo-spiral nerve was found to be beyond repair,—about five inches being absent; the wound was therefore closed. On September 26, 1917, a tendon fixation was performed in the manner already described. The case has, therefore, been under observation for ten months and the tendon ligaments are still acting well, showing no signs of loosening or stretching, their points of attachment being indicated by prominences of the bones. The hand is held dorsal-flexed and although the extension of the fingers is limited to that produced by the lumbricals and interossei, it seems fairly adequate for most purposes. The patient can use the right hand almost as well as the left for dressing, feeding and weight lifting, and whereas before the operation he could not write, he can now do so. For the last four months he has been engaged at his pre-war employment which consists in driving a colliery haulage engine in which both hands are necessary for the pulling of levers.

Tendon fixation is recommended as an alternative procedure to tendon transplantation, or the two may be combined by first performing the fixation and then transplanting the carpal flexors to the extensors of the fingers and thumb. It would be wise to do so in two stages, per-

forming the transplantation two to three months after the fixation, thus avoiding an unduly prolonged and complicated operation with possible matting of the tendons. The writer has, however, no experience of the combined operation.

References.

[1] Nederlandsch Tijdschrift voor Geneeskunde, No. 23, Dec. 3, 1898.

[2] Revista di Ortopedia, 1901, No. 1. La Fissazione Tendinea nelle Articolizioni Paralitiche.

[3] Zeitschrift für orthopädische Chirurgie, 1904, 21. Die Tenodese, eine Form partieller Arthrodese.

[4] Annals of Surgery, March 1913, and October, 1915. Tendon Fixation in Infantile Paralysis.

Discussion.

The President: We have had two very interesting and instructive papers. I particularly agree with Mr. McMurray as to the importance of large incisions in these tendon transplantation cases. In the earlier cases of tendon transplantation I think many people did not realize that; certainly I did not do so myself. The consequence was that in many of the earlier cases the transplantation which was carried out was of very little use. Another point which, I agree with the first speaker, should be insisted on, is the importance of choosing for this work muscles of sufficient strength to do the work which will be expected of them. In the original operations of tendon transplantation for calcaneus, the peroneus longus was expected to do the work of the gastrocnemius, which, of course, was absurd. Mr. McMurray did not say very much about the question of sensation. Perhaps when he comes to deal with the subject further in his reply, he will tell us more about that, that is, as to whether he thinks the loss of sensation is not very important in ulnar paralysis. Both papers are open for discussion.

Mr. G. R. Girdlestone: There is one thing I would like to ask Mr. McMurray, and that is, whether he does not make sure what the power of passive hyperextension is before he transplants the muscles. One of the principles on which, I know, he works is, to make quite certain that the action of the tendon is perfectly easy and unopposed, before he transplants any tendon into it. Another thing is equally pertinent. He will say that he exercises the tendons which he is going to transplant before he transplants them. I am certain he makes the most use of flexors of the wrist in the workshops, before he transplants a tendon. I emphasize these two points because one sees cases of musculo-spiral paralysis in which there is contraction of the flexors, so that the fingers will not extend easily. And there are cases in which the flexor muscles are very weak. The hand has been kept in a splint for a long time and not exercised, so that when you ask such a man to grip and bend it, he does it very weakly. I am sure Mr. McMurray will tell us it is useless to transplant tendons until they have been got into a state of wholesome activity.

Occasionally it may be necessary even to lengthen a tendon. I had an interesting case in a man who was a professional golfer, as were also his father and his grandfather, in fact, all his ancestors were professional golfers. He told me he got into trouble at three years of age for swinging golf clubs in the street and hitting passers-by with them. The flexor longus pollicis was so contracted that it would not come out in any reasonable time, and in doing a transplantation it was necessary to lengthen the flexor longus pollicis before one could procure full extension of the thumb with any ease. He also had extremely strong

extensors of the wrist, with much bigger tendons than usual, and extraordinarily small extensors of the fingers, all, obviously, the result of swinging golf-clubs habitually and doing very little else.

I would like to mention one more point about musculo-spiral paralysis. Mr. McMurray said all cases of musculo-spiral paralysis could extend the terminal digit of the thumb. I have met with cases in which the patient could not do this. In those cases it must be important to transplant the tendons into the extensor secundi pollicis. It is necessary for the surgeon to make sure that the man can extend the terminal digit of his thumb before deciding on the transplantation. It is a question whether good cannot be done by tendon transplantation in brachial plexus injury, say, two or three years afterwards, where the hand is rather lacking, and no active adduction of the thumb is possible; also when a man tries to extend his hand and he cannot extend the terminal digit of his thumb. He often finds it impossible to adduct his thumb and extend the terminal digit. In two cases I inserted the extensor carpi radialis brevior into the extensor longus pollicis, and those men were able to extend the terminal digit of the thumb, though previously this had been possible to only a limited extent. I also tried to give one of them adduction of his thumb by taking the palmaris longus and inserting it by rolling up the fascia into the metacarpal bone, near its head, keeping it in that position for some time. But that became stretched, and the procedure was not a success. I wondered whether anybody had tried to get that position by removing the flexor longus pollicis from its present position and bringing it out, so that its action would be to abduct the thumb.

With regard to tendon fixation, Mr. McMurray said he put the foot at right angles. Sometimes it is felt that it is better to put it at 10 to 15° above a right angle, so as to allow for some subsequent lengthening of the tendons.

In reference to making two holes in the tibia, my own personal habit has been to make one hole, and bring the peroneus longus or brevis through the hole, and fixing it not to itself but to the tibialis anticus tendon, so as to avoid making two holes and having two loops.

Major Elmslie: I felt rather sorry that Major McMurray did not introduce into his remarks, or preface his remarks, with some reference to the principles to be adopted or aimed at in tendon transplantation or tendon fixation. I feel that in pre-war days tendon transplantation is one of the subjects which, by proceedings sometimes carried out, has helped to get for orthopaedic surgery a bad name, because it has been advocated, perhaps, rather extensively, and has been utilized in many cases, I think, without proper consideration or forethought, first as to whether the tendons which were being transplanted could be so aligned as to carry out the new work intended, and, second, as to whether they had the power, in their transplanted position, to carry out the function required of them.

In transplanting a tendon, I think we should first make sure that transplantation is the only course possible, that is, that no recovery of function is possible in the muscle supplied by the nerve in question by any other means. I must confess I have had comparatively little experience of tendon transplantation, because I seldom encounter cases in which I think that procedure is fully justified. I do not do a transplantation until I am absolutely certain the nerve concerned has no possibility of recovery. Supposing we are satisfied on that point, that the nerve cannot recover, what other requirements should we investigate in the case? First, we should enquire are there any muscles which can be spared without loss of function? Second, is it possible to align these muscles in such a way that they can carry out the new function required of them? The third condition is: Have they the strength to carry out that function? The fourth condition I ought, perhaps, to have put earlier in order of importance. It is that we must settle in our minds exactly what it is we are going to require of these transplanted muscles. And that requirement will probably be different in every case of transplantation.

If I may take some examples, one is a kind of case which Major McMurray

left out, and which, in my experience, is the most successful transplantation of all, namely, the transplantation of muscles for a lesion of the posterior interosseous nerve beyond its point of supply to the extensor carpi radialis brevior. It is the kind of case where you have a paralysis of the extensor communis digitorum, and extensors of the thumb or, best of all, where there is paralysis of thumb muscles only, in the latter case from a wound of the back of the forearm, involving the lower branches of the posterior interosseous nerve, a lesion in which it is almost impossible to suture the branches of the nerve running to the thumb muscles. There is a paralysis of three thumb muscles, and you can spare individual muscles to replace each of those three separately. For instance, if the man has a palmaris longus, by transplantation of this, of the supinator longus, and one extensor of the radial side of the carpus, into the thumb, you can get absolutely complete replacement of every function of the thumb. That is the ideal tendon transplantation, where you are restoring the original function in every possible way. That, however, unfortunately, is a result which one can but seldom aim at.

In ordinary muscle transplantation what is our object? We cannot pretend to restore the extension of the wrist and fingers and thumb in absolute perfection as it was before. I feel that our object here is two-fold. The first is to give the patient voluntary extension of the wrist; the second, is to enable the patient to open out the fingers and thumb in such a position as to clear and open his grip. The trouble with musculo-spiral paralysis when the wrist is extended is that the fingers and wrist lie in *this* (demonstrated) position. It is not necessary in order to open your grip to be able to extend the wrist and fingers fully at the same time; it is sufficient if you can get the fingers out in a straight line, whilst the wrist is in a straight line with the forearm. I think *these* positions are essential. In transplanting for musculo-spiral paralysis you get a very full extension of the wrist by transplantation of the pronator radii teres into the extensors of the carpus. There is a further example in median nerve paralysis. I have not done transplantation in any case of median paralysis, but I think there is a future for it. But, again, we have to think out very carefully all the possible results we can get. My impression of complete median paralysis, where the hand is at its best, is that the man has a good general grip, that is, he can take hold of a good heavy object and hold it, he grips it with three fingers, and so can keep a good hold. But he has lost the movement of apposition of the first finger to the thumb, which is a very important one. Would it not be better, in a case of median paralysis, if we were to try to give the man an individual flexor of the index finger and of the thumb rather than combine the flexion of these fingers with those of other flexor tendons? My own feeling is that the movement, finger-to-thumb, is what we want to aim at in median paralysis. A further instance of thinking out the function which we propose for transplanting muscles is that of replacement of the quadriceps. Without the use of the quadriceps one can walk along level ground without there being any noticeable alteration in the gait. Many years ago our President, on an occasion when I went to the National Orthopædic hospital, showed me a boy who had been sent to his consulting room for transplantation to replace the quadriceps, because of infantile paralysis affecting that muscle, and he showed me how the boy walked up and down the room. One could not tell from his gait which was the paralyzed side. Mr. Little said he did not intend to transplant to replace the quadriceps. If we are going to transplant in order to replace the quadriceps what do we intend to do and with what object? To enable the patient to extend the flexed knee when his full weight is on the limb. I should like to ask those who have transplanted the biceps and other hamstrings into the quadriceps two questions: First, can your patients, after that transplantation, from a flexed knee position, come up straight; and, secondly, can they walk upstairs with a full action? If they can, the muscle has carried out its new function; if not, you might as well not have done the transplantation.

With regard to Mr. Rocyn Jones' tendon fixation in musculo-spiral paralysis, I would put to him again that question as to the function we want to carry out. His fixation keeps the wrist extended, but it does not enable the patient to clear the grip. As regards detail, there is a great deal that one might say

in criticism of Major McMurray's paper, but I do not wish to go into that—I prefer to concentrate on principles. Still, there is one point of detail which I would like to mention. Mr. McMurray alluded to transplantation to replace the deltoid and said it was a failure. Well, it is not a failure. The fact of the matter is that one seldom comes across a case in which it is possible to transplant to replace the deltoid, because either you are dealing, as we did in pre-war days, with cases of infantile paralysis in which the loss of the deltoid is only part of a wider paralysis in which the rest of the shoulder muscles are affected and in which, for that reason, it is difficult to get any muscle with sufficient strength to transplant, or else we are dealing with one in which there is a localized paralysis of the deltoid without injury to the shoulder joint and without injury to the surrounding structures, a kind of case so rare that I have not seen one. For a bullet to traverse the shoulder and catch the circumflex nerve without smashing the neck or the head of the humerus is a thing which it is almost impossible to believe. A few months ago I did a transplantation to replace a deltoid in a man who had complete loss of the deltoid from a wound in which the deltoid and the skin over it were cut right away. After the operation he can elevate his arm well above his head. Transplantation of the clavicular part of the pectoralis major is sufficient to replace all the anterior part of the deltoid and, if you have the supra-spinatus muscle left, the patient will get almost complete functional return in the shoulder. I go further than that and say the pectoralis major can carry out these functions in some cases and elevate the shoulder without transplantation at all. It is possible to replace the deltoid, but the cases which are suitable for transplantation are exceedingly rare.

Captain Winnett Orr. I had prepared a paper on this subject for presentation to a session on nerve surgery, and that paper was presented by title only. But there were certain points in the paper which Captain McMurray gave us this morning, with details of surgical procedure and the anatomical relationships involved, which have been most interesting and which I would say a word about. In my paper I emphasized the fact that these procedures were particularly useful and applicable as soon as wounds were soundly healed in cases in which injury to muscles or tendons involved considerable loss of function, especially in the hands. It is possible to restore to a hand which is almost entirely useless when it comes to the hospital useful functions which will enable the man to return to a useful occupation, by making use of the material left in the badly damaged arm. A number of the cases we have had at Cardiff have demonstrated this nicely. One case was that of a sailor, who went back to duty. He had a scar involving two-thirds of the dorsal surface of the arm. He had no ability to extend the fingers and, therefore, to do useful work. Transference of tendons enabled him to recover that ability to extend the fingers, and, as I say, he went back to duty. Pensioners come to us with the use of the hand apparently gone forever, but they can be made to carry out useful functions, and the movements can be restored by using tendons that are functioning.

There is one point which, I think, deserves special emphasis, although all these fundamental principles have been repeatedly emphasized, and that is, that in transferring these tendons, in addition to preserving movement, and procuring relaxation, etc., it is very important to deal with the transplanted tendons in such a way as to protect them, as far as possible, from adhesions. That, also, should be taken into account in making the incision in the first place, that is, one should so make the incision as to obviate that possibility.

With regard to the deltoid injuries, of which Major Elmslie spoke, it had been my intention to mention points which he has clarified, that in many of these cases in children recovery will take place without operation if the arm is maintained for a considerable period in a favourable position. The principles of that have been emphasized by Sir Robert Jones for years. It is very important to bear in mind that when the arm is in such a position that the deltoid is relaxed for a long time it will recover by the acquisition of a different function taken on by surrounding muscles.

In operating on the foot, I have used details of technique which I have found

useful and which save time. I do not undertake the passage of tendons by using a drill, but I take a mastoid chisel, by means of which a hole can be made in thirty to forty seconds, and the tendons can be passed through it with great ease.

I thank you for the privilege of attending here, and being allowed to say these few words.

Mr. Naughton Dunn: Stiffness of metacarpo-phalangeal joints suggests that there is room for discussion as to the time at which this operation should be undertaken. I do not think any tendon transplanting operation should be undertaken in the hand until we assure ourselves that all the potentialities for recovery are present, that is, until the patient can completely open and close his hand. For the purposes of transplantation we require strong muscles, and unless the joints which the muscles control allow free passive movement, the subsequent development cannot be complete. And if you are transplanting tendons, those of the same group will replace one another more efficiently than if you take them from another group. In the case of the foot, if you wish to use a tendon to invert the foot, where there is paralysis of the tibialis anticus, the peroneus tertius makes a more efficient inverter than one of the other peroneal muscles.

And I think the question of reëducation is one which might be more considered.

With regard to tendon fixation of the foot, I agree with Captain McMurray that the peroneus brevis is better than the peroneus longus for fixation.

Mr. S. Alwyn Smith: I quite agree with what Mr. Dunn said about the preparatory treatment before tendon transplantation is undertaken. I think that in the musculo-spiral cases which we see and which have lasted a considerable time, there is bound to be some limitation of movement in the metacarpo-phalangeal range, which should be overcome before anything operative is done. At the same time, a continual course of massage and faradism of the flexor muscle should be carried out. I have one case in regard to which I have waited three months to do a tendon transplantation, and the patient is not ready yet. He is a pensioner. He cannot flex the metacarpo-phalangeal joint beyond 30 degrees, even now. With regard to the anterior crural nerve, I do not agree with what Major Elmslie said about crural paralysis. The usual type of joint which you get in war-time surgery is totally different from that we used to meet with in the days of poliomyelitis, in which one or two branches going to and governing the crureus might be saved. I have had one case of gunshot wound of the groin, in which the missile came out at the sacro-iliac joint at the back. There was total paralysis, and the man could not walk. I waited for six to eight months, and nothing happened, and at the end of that time he was unable to put his foot to the ground. I did a tendon transplantation of the biceps on the outside and the semitendinosus, on the inner side, and after three months he had a very strong functioning extensor But as to his being able satisfactorily to pass the big test of being able to stand on one leg only, I do not think he could, nor do I think he will ever do so. But he could walk satisfactorily without an appliance.

With regard to gunshot wounds of the forearm involving the median nerve, I have transplanted the flexor carpi radialis to the flexor longus pollicis and the flexor profundus of the index finger. The function was good, but, unfortunately, the loss of sensation rather led to difficulties. The man was very pleased with himself at the end of six weeks, when he left. But he came back with a very bad trophic burn, the result of burning himself with a cigarette, and the usual consequences happened, that is to say, it took a very long time to clear up.

I think Major McMurray is rather optimistic about cases of paralysis of the ulnar nerve. We see a good many of these, and perhaps they are extra bad ones, especially in pensioners, those who have been to various orthopædic hospitals or centres, and who come back with the ordinary flexion deformities of the ring finger and little finger. I have never yet seen a case of ulnar paralysis which was able to return to military duty.

MAJOR ELMSLIE: May I have a word in order to explain? I have not, as a matter of fact, seen a case of anterior crural paralysis as a result of a gunshot wound, so I was not alluding particularly to military surgery, but rather to surgery in general. And Major Alwyn Smith's case bears out not the detail but, I think, the principle of what I put. By transplanting the muscles, it did enable them to carry out the new function which was required of them, which, in this case, was an extremely important one; and I think the further test of the man being able to extend the leg with the full weight of the body on the knee was not required.

LIEUTENANT BILLINGTON (U. S. A.): Very satisfactory progress has been made in operations on the lower extremity, but I think the work of tendon transplantation on the upper extremity has been almost entirely developed since the war began, and we are very interested to see the results, and to know that other men are getting satisfactory results, which encourage us to go ahead in this matter.

There is one tendon transplantation, but somewhat outside the strict subject of this discussion, which is not often needed for gunshot injuries, but which might, perhaps, be discussed for a moment in this connection, and that is transplantation of the extensor proprius hallucis into the metatarsal. This operation was frequently done for infantile paralysis before the war, and there have been very satisfactory results, except for one fact that I observed in cases of my own, and that was a dropping of the great toe, and flexion of the interphalangeal joint, which made it difficult for the child, in those cases, to get a boot on the foot. Oftentimes, therefore, these patients develop corns and ordinary hammer-toe. To obviate that, I have used this technique: Split the extensor proprius hallucis into thirds, an inner one-third portion, and an outer one-third portion divided completely as far down as is needed to go on the toe, and use these two-thirds to pass through the drill-holes in the distal portion of the shaft and first metatarsal, being particularly careful while doing that to hold the toe in a straight line, taking up all the slack in the transplanted two-thirds, so that the toe will not be held in a cocked-up position, so that it can go down to the straight position, and will not cock up or drop further. That obviates a troublesome and oftentimes uncomfortable complication in the cases I have mentioned.

MR. BENNETT: I used to transplant tendons to a great extent in early days. The question of transplantation for deltoid paralysis interests me very much. At one time, cases of Erb's paralysis, or of "obstetric paralysis," which we see so often, did badly until we had General Sir Robert Jones' idea of keeping them well up. But there were cases which did not react, and in those I have transplanted the whole pectoralis major by practically taking it from its insertion into the clavicle and acromion, and dissecting away the deltoid from opposite to it, severing it from the bone. I have seen two cases in which excellent results were obtained in that way. I do not say they were perfect results, but very fair ones for such an operation. In such cases as those, I do not think arthrodesis would have secured such good results as I got from transplantation.

I have been very interested and pleased with Major McMurray's opening contribution. There are certain points in it which struck me a great deal. One point I do not think he dealt with, and that is the terminal phalanges of the thumb. I am myself the object of such an accident. I have no extensor primi, but I have a secundi which does all my work.

In all my cases of tendon transplantation I make a point of using the secundi, because it acts on every joint. I do not agree with Major McMurray in that he says he does not trouble about the secundi pollicis. Beyond that, I think his paper is all that one could desire, and there are certain points which I thank him very much for.

With regard to the question of the anterior crural nerve, my experience of transplantation for anterior crural paralysis is not very great. I do not think I have ever seen, in such cases, anything like a perfect result, such as Major Elmslie would desire. That is so much the case that I have excluded it from

my repertoire of operations to a great extent, and in the cases where I thought it was not possible to do it, I have done an arthrodesis of the joint, and I have carried it out with success. That is to say, I have got a vital, if wooden-like, limb, which is better than a flail and half-useful one.

With regard to fixation of the ankle-joint, I feel that in the majority of cases. —and I am specially thinking of our wounded,—if you have a sutured nerve and there is any chance of action of the muscle, I prefer to let the patient go about with an equinus boot and spring. He then gradually acquires power What, I think, has not been sufficiently appreciated in our hospitals is the question of the relaxation of the extensor muscles. They have loss of tone. and if you relax them, and then gradually get back their tone, you will find, as a result the patient has a useful joint. You get a drop-foot, and that persists during life if you do not get an angular splint on it. It will relapse. But if you have a proper splint on it, it will regain a lot of power. I think if we insist on that we shall be able to save a lot of tendon transplantation, though I agree that in some cases you must have some new elements to help those actions.

With regard to the transplantation of the peroneus brevis, I generally use that muscle, but not by boring through the tibia. I always aim at simplicity in my operations, because I think it is the apex of our art. I never make a second operation if I can help it. If I can, I run the tendon underneath the annular ligament, and round the front. I avoid anything which complicates the operation. So far, I have seen very fair results from transferring it beneath the annular ligament. I know it is difficult, but these cases do well.

Mr. McCrae Aitken: I do not think there is anything to add to what has been said, except on one point, and that is, to ask whether Mr. McMurray meant two inches above the ankle for the hole for tendon fixation in drop-foot, and not, as I think he meant, two inches above the ligament. I think he will probably agree with me.

I am glad so many people have referred to the question of the abduction and full extension of the thumb. There is great difficulty in getting a useful hand, and scars round the wrist come into the same consideration. One is doing plastic operations often, in order to get a full grip, especially if the patient is a working man. One case I had was in the person of a bricklayer, and I had to get an apparatus for him to enable him to lay bricks.

I have followed Major Elmslie's advice, and especially in a case in which only the thumb was paralyzed. I got a strong muscle, and he had an extraordinarily strong palmaris.

Mr. Laming Evans: There is one point of principle which I am not certain has yet been introduced. If so, I missed it. It is ablation of the function of an over-acting muscle. That question entered very largely into transplantation done for infantile paralysis: I have had very little experience of transplantation for gunshot wounds. In infantile paralysis there was one peculiar deformity, where ablation of the function of a muscle and its transference to the other side was of benefit. That was in infantile talipes valgus, where the outer portion of the sole is drawn up, with or without sinking of the longitudinal arch, but generally having no association with it. In those cases, if the function of the peroneus longus is ablated and it is transferred to the other side of the foot and fixed into the tubercle of the scaphoid the result is good. It is an operation which I have done twenty or thirty times. I have watched my cases, and I am convinced that after that there is very great benefit in that particular deformity. I am inclined to think that in such case it is more by the ablation of function than by the introduction of a tendon on the other side. which does not give the patient much muscle power, but often acts as an extra-articular ligament. The function of the foot is invariably improved in that way.

Mr. White: This discussion has been, largely, one of technique and end-results. We have not heard much of indications for the operations. There is no question about whether an operation should be done when a muscle supplied by a nerve has been cut away, as well as the nerve itself, and where the question of a primary operation on the nerve is hopeless. And we have not had

any discussion on the question how long after a nerve suture has been done and there is no return of function the case can be adjudged a failure, nor what should be regarded as the time for different nerves. We have first to decide whether an operation should be done, not how it is to be carried out. The same in regard to arthrodesis for the external popliteal, is it necessary, or is it advisable, to do arthrodesis?

Major McMurray (in reply): I thank you very much for your remarks, and for the kindly way in which my paper was taken.

With regard to the loss of sensation following in these cases, we cannot get over the possibility. You can restore motion, you can restore half the function of the hand, but the loss of sensation is a permanent result. Physiologists deny that there is any ingrowing from the cutaneous branches, and we have not seen any yet. In reply to Mr. Girdlestone, it would be useless to try to transplant a tendon to act on a stiff joint; you cannot keep up your treatment of stiffness until after tendon transplantation; it must be mobile and smooth before you do anything.

With regard to the terminal digit of the thumb, I had a hint about that. I have explained that a man can extend the terminal digit of his paralyzed thumb without any transplantation. I have seen 500 cases of nerve paralysis, and of those, 200 have been of the musculo-spiral nerve. I have watched them, and they are able to extend their thumb. Gentlemen in this room have seen cases in which the thumb could be extended three weeks after suture, and recovery was adjudged to be taking place, and I have shown three cases in which no operation had been done, and they also could do it. A man abducts his finger and brings it to the thumb, and he can extend the top of his thumb.

With regard to Major Elmslie's remarks, in which he said you do not need extension of the wrist, you may not, but I think it is of the greatest advantage in the world to have it. The extension is only a passive thing, and it does not give the same amount of "strike" and usefulness and the same fine movements of the fingers as a man gets when he can extend accurately. With regard to posterior interosseous paralysis, I am sorry I did not mention that. My notes were lost, and I forgot about it. I agree that once you have interosseous paralysis you never have a case without scar tissue on the extensor aspect of the forearm. We know that after nerve suture the prognosis is good if you get rid of the scar tissue. End-to-end suture of a nerve in the middle of its course gives a hopeful outlook. If you do the suture at a point at which branches come out, you double the amount of scar tissue for each branch, hence you have four or five times the scar tissue at the junction that you have in the middle of the nerve. That is the reason why the posterior interosseous, where it gives off branches, will not do well with nerve suture.

I agree with Mr. Aitken, I did not mean two inches above the ligament. With regard to Mr. Alwyn Smith's remarks, there is only one reason why it is a useless hand, and that is the stiffness. If it is a mobile hand, with mobile fingers, it is useful. You never have a useless hand with ulnar paralysis. The little finger is weak, but he can move every finger.

With regard to Mr. Bennett's remarks, I do not agree with what he says on the question of arthrodesis. We are going back many years when we talk about arthrodesis, as compared with transplantation. Major Elmslie has probably seen many of these cases. We have ten or twelve of these cases which before, could not walk at all, but are now, after tendon transplantation, walking up and down the ward: we transplanted the biceps and the semi-tendinosus. The mere fact of being able to go upstairs does not matter, it is an academic point, it does not really make any difference. We have given, by the operation, a stable knee, whereas previously the patient had not such.

Several people spoke about cases in which recovery might be hoped for without tendon transplantation, such as after the use of a splint. No one would think of doing tendon transplantation before those means had been tried: we do not think of doing it until we are certain there is absolutely no chance or possibility of recovery. That is fundamental: there must be no talk of tendon transplantation for the mere sake of getting a particular result.

THE BRISTOW COIL AND THE TREATMENT BY GRADUATED MUSCLE CONTRACTION.

BY ALBERT H. FREIBERG, M.D., CINCINNATI, OHIO.

It is the object of this paper to attract attention to a method of physical therapy which is as yet but little known in this country and which comes from the war practice of our English allies with the assurance of a considerable usefulness. In view of the great tasks of physical reconstruction which are presently to be brought to us as the result of the war in which we are engaged, we must welcome every real addition to our resources. I have undertaken to present a short account of this method for the reason that I have had the opportunity to submit it to a quite thorough practical test with the result of corroborating the merits which have been attributed to it. I have nothing to contribute which is original; neither shall I endeavor to give an extended description of the method since this is readily accessible in the book by Mr. W. Rowley Bristow on "The Treatment of Joint and Muscle Injuries." At the same time it is necessary, in order to make myself understood, that I should make a brief statement with regard to it.

It will not be needful, at this time, that I should discuss the advantage of caring for the condition of the controlling musculature after joint injury since this is generally conceded. The use of massage and of carefully controlled active movements against resistance have become common for this purpose and it is now generally acknowledged that they are of great value. At the same time, we realize that truly efficient massage is by no means always to be had, that its results in the severer forms of joint injury are often slowly attained and that the dosage is not only most indefinite but also entirely dependent upon the personality of the massage assistant. It is not to be understood, however, that this method is intended to supplant the older ones; they are to be used in conjunction.

The fundamental idea of this method lies in our ability to stimulate the damaged muscles to contraction by an induced current in such a way that this may be exactly graduated both as regards degree and rhythm; we may thus begin with contraction of minimal intensity and very slow rhythm and proceed to increase in both regards according to the functional response which is thereby obtained. We have also the very great advantage of being able to limit our stimulation very nearly to a particular muscle or group of muscles and to an

extent not possible with the older methods. The current which is yielded by the Bristow coil differs from that of the usual faradic coil only in so far as it may be used in very great intensity without producing pain and, as before remarked, with the opportunity of quite definitely regulating and graduating the dosage from treatment to treatment and from case to case, as well. No effect is attributed to the electricity as such, except as it is used as the means by which the muscle is made to contract to the desirable degree and frequency. Whether the muscular contraction which is produced in this manner is closely related to the normal physiological contraction in the local metabolic changes resulting therefrom and upon which we depend for definite improvement in strength may be open to question; that the effect is identical can scarcely be claimed. At the same time, the true measure of usefulness of such contractions is to be found in the improvement in both the strength and volume of the muscles. Measured by this standard, my trial of this method appears to have demonstrated definitely the justice of Bristow's contentions and it has, to my mind, established a fixed place for it in the treatment of many joint and muscle injuries and of certain paralytic conditions, as well.

For a description of the apparatus and the manner of its use I shall refer to Bristow's book. It is worth while saying, however, that although it was impossible to procure the apparatus in this country, for a time, it is now being made here in acceptable form and that it is likely to be considerably improved with respect to the mechanism for regulating the current. Although it has not yet been possible for me to observe the effect of the method in a very large series of cases, the cases have been selected with care. After a short period of personal experiment with the coil I turned its use over to a trained masseuse by whom all of the subsequent work was done, under supervision. Bristow's directions have been followed with fidelity and without modification except as we have experimented with active electrodes of different shapes; thus we have found it advantageous to use a longer and narrower electrode for picking out individual muscles in the forearm and leg. It is quite surprising to find to what extent and with what accuracy this may be done. I shall cite a case for the sake of illustration. A woman had sustained a spiral fracture of the proximal phalanx of the ring finger, three years ago; the proximal interphalangeal joint was entirely stiff. The x-ray showed that flexion was blocked by the forward projection of the proximal fragment. This being chiselled away, it was possible to completely flex the joint. After considerable treatment by massage and movements, the patient was

still unable to produce active flexion. With the coil it was possible to produce isolated flexion of the ring finger and treatment by this means very soon resulted in a gratifying restoration of motion. It was quite remarkable that the motion produced by this current was painless at a time when passive motion to the same extent could scarcely be endured.

It would be profitless to report in detail the cases in which this method has been used; it has been tried, however, in all the various types of cases for which Bristow has recommended it, with the exception of traumatisms of peripheral nerves. On the other hand we have used it in some cases of poliomyelitic paralysis in older children and apparently with marked benefit. As a result of this experience, I feel justified in saying that the method may be confidently looked to as a valuable addition to our methods of physical therapy and that we should prepare to make free use of it in the work of military reconstruction. In doing so, however, it is by all means desirable to become thoroughly familiar with the technique beforehand and to adhere closely to Bristow's injunctions. If used carelessly it is possible to cause pain and great discomfort with the current. If properly and carefully applied, on the other hand, it is striking to observe how the quadriceps may be made to extend the knee with great force and without any pain whatever. This may indeed be looked upon as a real test of its value. While it is not offered as a substitute for efficient massage and certainly not to its exclusion when it may be had, the method of treatment by graduated muscle contraction will often be available when truly good massage is not and especially so in military practice.

My experience with the Bristow coil and the method of treatment by graduated muscle contraction has been entirely in private practice and therefore under conditions very different from those of military reconstruction work. It has already been remarked that this experience has been in accord with Bristow's: this may be said without reservation, as far as the fundamental statements are concerned. In some respects, however, it seems worth while to add a few words of comment as the expression of a purely personal experience. While the treatment should be entirely painless if the current be properly managed, it can by no means be denied that the effect of stronger currents is unpleasant. If the muscle be very strongly contracted, the contraction may be painful even though the local effect of the current is not. This may be easily ascertained by experiment on one's own forearm. It is not surprising, therefore, that the treatment is

not well borne by young children and nervous adults. This does not mean that it is not to be used in them, but that more than usual care must be taken in the first few sittings and the graduation must be very slow, indeed. In most patients it is very easy to overtire the muscles—ten contractions should be the maximum, at first. The core should not be pushed entirely in, when beginning, but worked farther and farther in each time. It is most important to heed the injunction to so arrange the position of the limb that complete relaxation is secured of the muscles which are to be treated. It is rarely, if ever, necessary to use the whole strength of the coil.

I have long before now given expression to the opinion that the atrophy of muscle which is so commonly observed in connection with joint injury and disease is not to be adequately explained by the theory of disuse; with this Bristow is in accord. If complete recovery from joint injury is not to be assumed until the controlling musculature has been brought to its primary strength again, then, on the other hand it must also be assumed that, in the presence of a joint lesion which is still active or even progressive by reason of an infectious character, it will not be possible to restore muscular strength by electric or other stimulation; on the contrary, under such circumstances it should be abstained from altogether so long as such conditions are in evidence. This injunction is of added force in view of the fact that in joints the elements of trauma and infection are often found in combination and, what is more important, that the recognition and determination of the infectious element are under such circumstances frequently far from easy. This is said, therefore, by way of caution; should the infectious agent be still in operation, muscle stimulation can do naught but harm. This method is to be used not as routine for every joint injury, but rather as the result of deliberate individualization; employed in this manner it will prove to be of great value.

SEVERE ACUTE SPRAINS OF THE KNEE JOINT.

BY MAJOR MAYNARD C. HARDING, M.C.,

Chief of Section of Orthopædic Surgery, Base Hospital, Camp Lewis, Washington.

DURING the first eleven months of 1918 we have treated at Camp Lewis Base Hospital, seventy cases of severe acute sprain of the knee joint. All but six or eight of these cases have been treated in one of the orthopedic wards, and all but that number under my supervision. Acknowledgment is herewith made of the excellent work of all the ward surgeons associated with me in this study.

In view of the importance of diagnosis, some statement should be made of what is and what is not included in this series. It does *not* include the following: Twenty cases admitted as sprain which cleared up under rest and hot applications, returning to duty in one week; twelve cases of abrasions and wounds in the region of the knee in which the joint damage was indefinite; five cases of synovitis following a hike, without definite history of a trauma. These cleared up rapidly—three of them after aspirating a large amount of clear synovia. Ten cases of acute semi-lunar displacement—all recurrent and not accompanied by other signs of sprain. A large number of cases of chronic hypertrophied fringes and thickened alar bursae resulting from previous trauma, which had been lighted up by accident or strenuous work. These latter are a problem within themselves, and not less than one hundred have passed through the orthopedic clinic.

In the cases here reported all the classical symptoms and signs of sprain were present in every patient: History of accident, immediate disability, usually total, pain, prompt swelling, effusion, and tenderness over the torn capsule. As stated, they number seventy, the majority of which have been discharged, while those remaining in hospital are far enough advanced to warrant an accurate prognosis.

After comparing notes with surgeons from a number of camps, I am convinced that this type of injury is rather more common here than elsewhere. This applies equally to fractures of the ankle joint, of which we have had some sixty to date. The reasons seem to be two: First we have a longer wet season than any other camp. Second, our terrain is everywhere composed of smooth round rocks from the size of a marble to big cobbles, loosely imbedded in a porous soil. In the wet season they are slippery; in the dry they roll, affording the runner and jumper poor footing. It is significant that the majority of these sprains and ankle fractures were acquired either while running or jumping.

As to location of the sprain, they are classified as follows:

General sprain, forty per cent.
Internal lateral ligament, forty-two per cent.
Internal semi-lunar cartilage, thirty-one per cent.
External lateral ligament, one case.
Periosteal tear internal condyle of femur, two cases.
Cracks of patella, three cases.

It will be noted that some patients present more than one diagnosis—internal lateral ligament and internal semi-lunar cartilage being the common combination. Twenty per cent. gave a history of previous similar injury.

All had effusion. Sixty-five per cent. were aspirated, six per cent. being aspirated twice. Of the forty-six cases thus aspirated, eighty-seven per cent. had bloody fluid, ranging from blood stained synovia to blood so pure it partially clotted on exposure to the air. Thirteen per cent. had clear fluids, half of which were obtained on first aspiration, and half on second, following a bloody fluid. The amount varied from 30 c.c. to 120 c.c., the average being 63 c.c. All fluids were examined by smear and culture. While the smear showed an occasional organism, the cultures were invariably negative with the exception of one, which showed a growth of gram negative diplococci. Since that knee gave no signs whatever of an infection, behaving exactly like the others, it is fair to presume that this was an accidental contamination.

The x-ray findings, naturally, were mainly negative, though some interesting and valuable positive findings were reported. Three crack fractures of the patella were noted. Three old dislocated semi-lunar cartilages were diagnosed and later verified by operation. Thickened and slightly calcified alar bursae were noted in a few cases. Two cases presented periosteal tears of the internal lateral ligament from the femoral condyle.

It is seldom that the pathology of the capsular and synovial injury is examined by the eye and touch in this type of injury. Four of this series came to operation—two for torn semi-lunars on the sixteenth day, one for repair of the capsule on the tenth day; one for a congenital hernia of the capsule on the thirty-fifth day. To these may be added one case operated at the Letterman General Hospital on the tenth day. The damage to the capsule ranges from stretching, which is the condition common to all grades, up to the completest and most bizarre tears running almost one-third of the way around the joint. The stretching is accompanied in all but the mildest types by tearing

of individual fibres of the white tissue, just as in other localities. To the original trauma must be added the stretching of the capsule by the effusion, which, in my opinion, is a prominent cause of disability and slow recovery. The synovial membrane is apt to be torn at the same region as the capsule. The entire inside of the knee joint at the tenth or sixteenth day looks as if lined with wine-colored velvet. The venous engorgement is so pronounced, and the swelling of the synovial membrane is so marked that one is struck forcibly by the intensity of the reaction going on. After viewing it, one is dense, indeed, if he persists in ordering early motion and weight bearing. The alar bursa is thickened and partakes in the reaction. Its swelling brings it often well between the bones and makes it more liable to be pinched.

The crucial ligaments are rarely involved, only one case showing such damage. The reason lies in the mechanism of the trauma. It is a flexion injury. At the instant of the sprain the knee is usually slightly crooked. It at once bends and the patient falls to the ground, or into some position where the tension on the crucial ligaments is relaxed. In those cases where the straight knee receives a blow from one side, and cannot crumple, crucial damage may be expected. Such was the condition in our one case, which was accompanied by extensive tearing of the capsule.

Profiting by the observations of a large number of similar cases, an effort was early made to standardize the treatment along certain broad lines, according to the pathology of the injury and the mechanism of repair. As soon as the case has been examined a light board splint is placed under the leg, if handling is painful. A tentative diagnosis is made and an *x*-ray secured at once. Upon receipt of the report from this laboratory the knee is aspirated, if enough fluid is present to distend the capsule at all.

The technique of aspiration merits more than a passing mention. Properly done, it is a safe and almost painless procedure. These cases are taken to the clean surgery, and the same rigid antiseptic technique as for a major operation is observed. No local anesthetic is used unless the patient is very nervous. He is cautioned not to bend his knee lest he break the needle off inside. A moderately course needle attached to a Luer glass syringe is used. Locate the outer edge of the patella one finger breadth below its upper end. Point the needle inward at right angle to the leg and tilt it backward enough to clip under the edge of the patella. If the patella is struck, the needle may slip in front. If pointed too far back the mesial edge of the condyle will

be struck and severe pain caused. Carry the needle in about two inches by a steady thrust, then gently draw on the piston. If no fluid comes, push in until the bone is reached, which will be at a depth of about two and one-half inches. The tip of the needle now lies in the hollow between the condyles under the center of the patella. At this spot redundant folds of synovial membrane are not apt to block the needle. At any other point in the knee joint this will almost invariably take place, causing great annoyance and even preventing aspiration. Part of the first syringeful is squirted into a sterile culture tube and sent to the laboratory. When no more fluid comes, the assistant grasps the front of the leg above and below the joint, encircling as much of the limb as possible. The hands are slid together, milking the contents of the joint toward the needle, when more fluid can usually be drawn. The puncture wound is sealed with collodion.

A cotton compression bandage is applied and if much pain is present, or any semi-lunar involvement, a posterior moulded splint is added. Forty-five of our cases required both. The patient is returned to bed, where he is kept so long as swelling and fluid persist. This is rarely over three days. He is then allowed up on crutches, but not allowed to touch the foot to the floor. In a few days, if no swelling or pain recurs, he is allowed to bear a little weight, still using his crutch. This will average about the ninth or tenth day. If at any time swelling recurs, he is put to bed until it subsides. This is of the utmost importance, and if neglected will lead to the formation of an indurated, boggy joint that is slow to resolve.

The duration of pain with the patient at rest and dressing applied showed an interesting difference, according to treatment. The aspirated cases had pain for an average of one and one-half days, while the unaspirated cases, with all equal distention, averaged eleven days. From the first, these joints are baked with a small portable electric baker. During the baking the patients gently rub their knees and legs. As soon as soreness is gone more forcible massage is given, and the baking extended to an hour daily. The posterior splint is removed as soon as pain and soreness leave; within a few days at most. Two five-yard flannel rollers are then given the patient and he is instructed in putting on a figure-of-eight bandage. This he wears constantly for about three weeks, when he takes it off at night. The man takes his bandages with him from the hospital and is ordered to wear them at least three months. Before being sent from the hospital he is taken for several hikes, reporting for examination on his return. The last

one is at least five miles, and he is not discharged unless he can stand this without reaction.

Cases showing semi-lunar symptoms are kept on a posterior splint four weeks. If they are to be operated it should be done after the symptoms of sprain have subsided. The two cases done on the sixteenth day did well, but I believe there was still too much reaction present. The last one opened in the fifth week has done better. The results of the treatment have been, on the whole, satisfactory. The average stay in the hospital was forty-six days. Eighty-nine per cent. returned to duty. Nine percent. to limited service. Three cases went recently to quarters, the ultimate disposition being doubtful.

On reviewing this series it is perfectly evident to me that these cases can be further subdivided into two classes. One, a general sprain with moderate effusion which may or may not absorb under pressure and rest. You can tell after a week that they will be ready for duty in about thirty days. It is from the uniformly fair results in this type that the "let-alone" policy of treatment has become popular. The other type may look the same, but the fluid is very bloody and tends to recur promptly. Definite capsular tears can be made out. They are usually of the internal lateral ligament, being quite often associated with internal meniscus displacement, or even bony injury. These cases, treated by the "let-alone" method, or the more harmful one of forced motion and early weight bearing, result in chronically weak knees. They react badly to every strain or trauma in after life, forming the bulk of the scores of chronic knees showing up in the orthopedic clinic. They need all the care here outlined, and often more, while from two to four months are required to return them to duty. Since twenty per cent. of these cases give a history of previous injury, it is fair to suppose that many of them will again break down, this being especially true of the severe type last mentioned.

CONCLUSIONS.

From a study of this series a few important lessons can be drawn.

First, careful diagnosis of the type of sprain.

Second, aspiration of any distended joint promptly, since practically all effusions are bloody and absorb slowly. I have found them present after many weeks and they lead to the formation of a thickened, chronic joint.

Third, prevent distention of the capsule, as it is one of the main causes of a weakened knee in after life.

Fourth, early baking and massage.

Fifth, strict supervision of the manner of returning to use.

SOME PRACTICAL APPLICATIONS OF PATHOLOGY TO THE WAR INJURIES OF NERVES.

BY SYDNEY M. CONE, CAPTAIN, M.R.C., U.S.A.

[From the Alder Hey Military Orthopaedic Hospital and the Thompson Yates Pathological Laboratory, University of Liverpool.]

INTRODUCTION.*

THE Microscopic Appearance of War Injured Nerves was described by me recently in *The British Journal of Surgery*, Vol. V, No. 20, and the *Journal of Pathology and Bacteriology*, Vol. XXII. Now we will deal with the macroscopic findings. For this work I have more than four hundred specimens, gathered during the last year while working at the Alder Hey Military Orthopaedic Hospital.

The material was examined at the operating table, and described at once, using the knowledge gained by the microscope to interpret the changes seen in the injured nerves.

The neurokeratin stain enabled me to settle at once any doubt as to the character of tissues described. One can, by free hand or frozen sections, make a satisfactory microscopic report on nerve specimens within ten minutes.

MACROSCOPIC EXAMINATION OF TISSUES.

In examining tissues one must note systematically: size, shape, location, color, circumscription or infiltration, consistency, translucency and homogeneity.

Protoplasm (cells) *en masse* is translucent (gelatinous) gray, more or less edematous and bulging; where it is compact the appearance is gray and opaque, fat is yellow, muscle red, arterial circulation pink, venous congestion blue, and broken-down blood brown. Fibrous tissue is hard to tear, grates on cutting, and may only be separated readily from surroundings when circumscribed or when it has reached its full growth and is beginning to contract. It cups on section when dense, and retracts about softer more cellular material.

NORMAL NERVE.

A normal nerve appears very much like tendon, but is not so compact or glistening. It is milky white and when flattened, individual pearly white lines may be seen on a translucent pink or bluish background (depending on the circulation). It may be readily teased—the individual bundles being held together by a very fine reticulum of connective tissue.

* Figures referred to are in the *British Journal of Surgery*, Vol. v, No. 20.

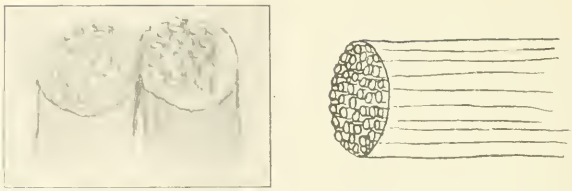


Fig. 1.—Nerve trunk. Bundles appear normal. Excess of connective tissue.

Cross section demonstrates numerous half millimeter-sized points in a pink translucent background. On pressure these protrude like pistils of a flower. One may be readily extracted from its bed.

The connective tissue about these bundles is continuous from sheath to the finest bundle (fasciculus) and carries a very excellent blood supply—large vessels being found under the sheath and at the center.

Smaller anastomosing vessels course alongside the inner fasciculi sending capillaries into them.

The pink or bluish color of the stroma depends on the preponderance of arterial or venous blood.

In pathological nerve tissue the appearance varies from the normal because of proliferation of nerves, connective tissue and blood vessels (which are enormously increased) and the presence of blood pigment, fat or muscle.

We must understand the tissues at the seat of injury, as well as the nerve trunk. The proper interpretation of the gross appearance of the material away from the mass of scar ("chelioide nerveuse" of Dejerine) will often save the surgeon much difficulty and the patient months of time in recovery. This knowledge of the macroscopic anatomy will give confidence to the operator in a position where he is often in doubt as to the kind of tissue he is cutting. There should be no question as to the fact that whatever he does to remove the dense compressing tissue is well done, for the nerve will do the rest whether sutured or merely freed. Many cases which appear to require suture, because of the firmness of the nerve or the conglomerate mass at the seat of dissection, would recover sooner if the surgeon desisted as soon as he recognized "nerve callus" connecting the two nerve trunks. Our earliest recoveries are cases in which the sutured ends were "nerve callus." Moreover, my guinea pig experiments demonstrate this material most active when transplanted. After division the nerve regenerates rapidly at both ends—the central end reaches maturity at

once, the peripheral end forms immature nerves by a multiplication of the sheath of Schwann cells (neuroblasts). These embryonal nerves mature very often through unexpected central connections picked up in one or more of four methods. (See Cone, *British Journal of Surg.* Vol. V, No. XX, 1918, p. 537).

The work done in the laboratory to confirm the gross descriptions and interpretations was done by a method (neurokeratin stain) described in this journal.

NERVE BULBS.

FIG. 2.

FIG. 3.

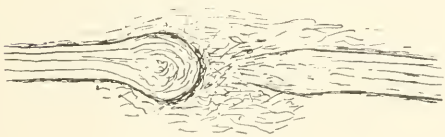


FIG. 4.

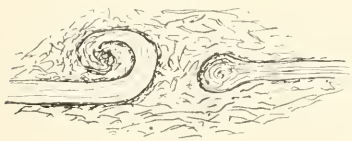


FIG. 5.

FIG. 6.

The nerve bulbs ("nerve callus" masses), whether seen as end bulbs, side bulbs or at the ends of nerves in amputation stumps are always circumscribed, rounded, hard, grayish white masses, resembling compressed fibrous tissue. There is a grating on section and one sees on close inspection (especially on pressure) innumerable fine gray translucent dots. Sometimes there are larger gray or grayish pink translucent areas in these "nerve callus" masses.

The gray color is due to bundles of young 1-3 sized, much nucleated nerve tendrills in a stroma of fine connective tissue (Figs. 430, 433). The translucent dots are cross sections of the very small bundles (fasciculi). Each fasciculus contains ten to forty tendrils (Fig. 413). When the stroma is very cellular and vascular a pink color is added to the gray.

When the bulb is seen in its earliest more cellular, nucleated stage of growth, translucent grayish pink, succulent, bulging, pinhead areas present themselves among the grayish pink lines. Not infrequently the nerve trunk fibres may be traced into the bulb entering at the side or center and spreading. These are milk white lines in a pink stroma which are gradually lost in the homogeneous gray of the bulb.

The symmetrical elliptical bulb seen in the continuity of an injured nerve, often contains pieces of shrapnel. This is succulent (oedematous) grayish pink with milk white lines traversing it. Sometimes they are gray and firmer. Whatever else may be present in the nature of inflammatory exudate, progressive tissue change, and foreign bodies, young nerve proliferation is always found.

This growth is not so wild nor so abundant as in the "nerve callus" of bulbs just described. The latter is the same kind of formation in a non-oedematous tissue. The firmer gray ones contain more of the interlacing young nerves in fasciculi, characteristic of "nerve callus." They are sometimes discolored brown by granular blood pigment. This tissue should not be excised—it offers an excellent medium for nerve growth and contains many continuous good adult fibres. Longitudinal incision (hersage) may be practised but it has been found that neurolysis (relieving adhesions) alone produces satisfactory results.

A nerve badly torn for part of its extent, does not always bulb. In dissecting scar from about an irregularly torn nerve one comes upon gray and white lines leading to minute globular, translucent, pinkish gray tissue resembling lymphoid follicles. These vary in size from 1 to 3 mm. and are continuous with fine gray to milk white lines of the nerve trunk.

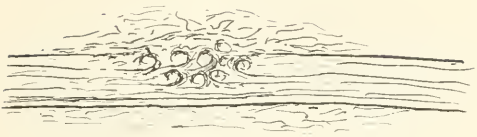


FIG. 7.

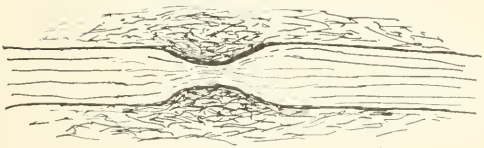


FIG. 8.

FIG. 9.

FIG. 10.

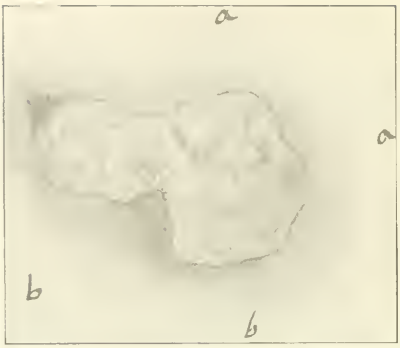


FIG. 11.—(*a*) Nerve callus; (*b*) Young nerve in bundles.

FIG. 33.

The microscope demonstrates these bodies to be miniature nerve bulbs of a very young cellular nerve type like Fig. 429; the gray lines are fasciculi of nerve tendrils (Fig. 432); the white lines are adult nerve fibres (Fig. 407). This nerve is regenerating unevenly—its smallest funiculi being torn at different levels. The tissue should not be excised for it is young proliferating nerve and offers an excellent medium for nerve growth. There are many adult uninjured fibres among the young ones. Removal of the scar and formation of a good occlusive muscles fascia bed should suffice.

NERVE COMPRESSED IN SCAR.

There are several types of contracted nerves due entirely to scar: one, compressed for a larger area; another, constricted for a very small extent. And, again, where with the constriction the nerve is diverted from its course. These nerves appear gray in color, are firm and may be rough or smooth.

Gross section is homogeneous and gray. Sometimes there are translucent gray or grayish pink dots indicating the presence of proliferating nerves,—this is rare. As a rule, the tissue is vascular and fibrous.

In one case out of more than four hundred the nerve, although constricted by a dense sclerotic band for one half an inch, showed on cross section bundles of milk white nerve fibres, protruding like pistils of a flower. There was no new formation of connective tissue within the sheath and the nerve fibres did not take the "neurokeratin" stain. Many showed balls of myelin (Wallerian degeneration). In this case relief of the constricting band would have been sufficient.

In the more common old densely constricted nerves, excision is required, for no adult fibres and few young ones are seen. If, however, on making a longitudinal incision, translucent gray areas or lines are seen in large numbers, relief from the surrounding scar is all that need be done. These areas are healthy young nerves and play the most active part in repair.

Nerves pulled from their path by scar or bone callus are narrowed and functionless. Function returns on relieving tension and freeing from scar.

One such nerve which has been slightly torn was examined. It showed both normal adult fibres and actively growing young nerves.

"NERVE CALLUS" IN ADHESIONS.

The gray firm tissue about war injured nerves, is commonly thought to be altogether scar tissue. I have shown in previous writings that adhesions about nerves contain nerve callus in 82% of cases. Now I can place the percentage higher.

Close observation will show translucent areas of grayish pink or gray, more or less circumscribed and easier to separate from their surroundings than scar. These masses are "nerve callus" (Fig. 431). They are invariably found close to nerve tears, around bulbs and I have found them around the seat of old nerve suture cases. *Finding "nerve callus" look for nerve injury.*

In one case such material in a skin scar led to an unexpected injury of the median nerve. In other cases, following this "nerve callus" has been of value in finding the nerve lesion.

In many instances it is formed from nerves to surrounding vessels, skin and muscle. This material may subserve a useful function in causing the otherwise embryonal nerve of the distal severed end to reach maturity. A central connection is made by these surrounding young nerves.

CHRONIC NEURITIS.

Nerves may be indurated, swollen, gray and homogeneous and yet show linear white markings when the seat of chronic inflammation (some observers refer to the changes about these infected war injured nerves as chronic neuritis). The cellular infiltration and connective tissue increase cannot be distinguished from the same in war injured nerves, any more than in any other clean cut or infected wound, where we no longer use terms like dermatitis and myositis. When these changes pass beyond the precincts of the injury and involve the nerve trunk some distance away, we may look on the condition as a secondary nerve involvement.

HYPERPLASTIC NEURITIS.*

With the cellular infiltration and connective tissue formation along the nerve trunk, I have noted in very many instances a great hyperplasia of young varicose nerve tendrils, winding about the normal nerve fibres in a very vascular loose connective tissue matrix. This cannot be distinguished by the naked eye from any other forms of nerve infiltration. Clinically, however, I take it to mean much. There is an intractable painful consalgia of war injured nerves for which even excision has been found insufficient in relieving, and for which Sicard has used alcohol injections with splendid success. I think this form of neuritis is due to the wild growth of young nerves among the old nerve fibres. The term "hyperplastic neuritis" might be used to indicate this condition.

COMMENTS ON THE PROCEEDING.

I indicated in the introduction that the connective tissue stroma of a normal nerve is easily frayed out and that the nerve bundles are readily pulled from their nests. This becomes increasingly difficult

* Not a most satisfactory term, but distinctive.

as the inflammatory new tissue formation increases and new vessels twine in and out among the old and new nerve fibres and bundles. The sheath and the epi-peri- and endo neurium, are all involved in the proliferation (Fig. 427). We find old blood pigment within phagocytes and free in the tissues. It is strange that we so seldom find small round-cell infiltration and polymorphonuclear leucocytes; they evidently quickly give place to a progressive tissue change.

It is the formation of this young connective tissue which makes so difficult the tearing apart and differentiation of the old injured nerve from the surrounding scar.

The scar is a much more intimate welding and intertwining of fine lines of tissue than is the "nerve callus" mass, and therefore much harder to tease or tear apart. Figure 33 represents this. Here we have the entire exsected piece photographed. The young nerve bundles are seen deeply stained and definitely separated, while the unstained scar is a mass of finely interlacing fibres.

I wish to thank General Sir Robert Jones for the opportunity afforded me to do this work. To Professor Ernest Glynn I am greatly indebted for his continued interest.

THE CHANGES PRODUCED IN THE GROWING BONE AFTER INJURY TO THE EPIPHYSEAL CARTILAGE PLATE.

BY S. L. HAAS, M.D., SAN FRANCISCO,
Captain, Medical Corps, U. S. Army.

[From the Pathological Laboratory and the Surgical Pathological Laboratory of Leland Stanford, Jr., University School of Medicine.]

(*Continued from page 99.*)

Experiment 44. 44 Days. Dog 129-79.

Operation. The lateral one-half of the metacarpal IV of the left fore foot is removed. The length of the bone is 3.0 cm. The animal died at the end of 44 days.

Gross Findings. The healing is good. The exposed lateral half of the bone is almost entirely enclosed by a new osseous cortex. There is no union with the surrounding dense connective tissue. There is a tendency for the bone to assume a round form like normal cortex. There is a definite marrow cavity within the new cortex except in the region of the articular cartilage. The epiphyseal cartilage plate has relatively a normal appearance. The Roentgenogram shows the operated bone with definite effort to assume its original form. There is some shortening and distortion of the epiphyseal end. (See Fig. 5.) The measurements are: Metacarpal IV., left, 3.2 cm.; difference, 0.25 cm.; right, 3.45 cm. Thus there is a loss of 0.25 cm. in growth. The length of the bone has increased 3.2—3.0=0.2 cm., while the normal increase has been 3.45 cm.—3.0 cm.=.45 cm.

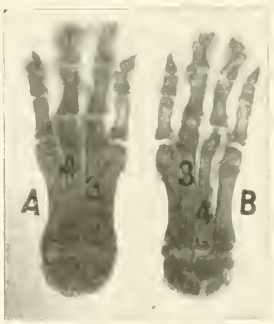


FIG. 5.—Experiment 44. 44 days. Dog 129-79. Removal of the lateral one-half of the bone. The second bone from the right, 4, of B, is the operated bone. There is only a small amount of shortening as the normal growth has likewise been small. Notice the tendency of the bone to assume its original form.

Experiment 45. 106 Days. Dog 21-54.

Operation. Removed the medial one-half of the metacarpal IV of the left hind foot. The estimated length of this bone is 3.0 cm. The animal died at the end of 106 days.

Gross Findings. The entire foot appears slightly smaller than normal. There is a small amount of articular cartilage still present. The epiphyseal cartilage plate has disappeared in the operated bone but is still present in the normal. The measurements are: Metatarsal IV. left (op.), 3.2 cm.; difference, 2.3 cm.; right, 5.5 cm. The loss in growth is 2.3 cm. The entire growth since the operation is about 3.2—3.0=0.2 cm., while the normal growth is 2.5 cm.

SUMMARY ON EXCISION OF ONE-HALF OF THE ENTIRE LENGTH OF THE BONE.

There is practically a complete cessation of growth after such an operation. This is due to the combined effect of injury to the epiphyseal cartilage plate and to disturbances of the blood supply both from the epiphyseal and nutrient arteries.

There is a tendency for the reëstablishment of the normal round form of the split half of the bone.

TABLE XII.

Exp. No.	Dog No.	Duration	Loss of Growth	Growth of Operated	Growth of Normal
43	150-87	3 days	0	0	0
44	129-79	44 "	0.25 cm.	0.2 cm.	0.45 cm.
45	21-54	106 "	2.3 cm.	0.2 cm.	2.5 cm.

GROUP V. CROSS INCISION WITH REMOVAL OF DISTAL FRAGMENT.

1. Through the Epiphysis.

Method. Made an incision across the epiphysis distal to the epiphyseal cartilage plate and removed the distal piece.

Experiment 46. 1 Day. Dog 27-56.

Operation. Removed the epiphysis of the metacarpal IV. of the right forefoot almost up to the epiphyseal cartilage plate. The piece removed is .4 cm. in length. The part remaining is 2.5 cm. The animal died the next day.

Gross Findings. The time is too short to show any changes in structure.

Experiment 47. 9 Days. Dog 28-73.

Operation. Removed the epiphysis of the metacarpal III. of the left forefoot just distal to the epiphyseal cartilage plate. The length of the remaining piece of bone is 2.6 cm. The animal died at the end of 9 days.

Gross Findings. The wound is clean and there are no visible abnormalities to be found. The measurement of the operated bone is: Metatarsal III., left, 2.6 cm. Thus there is no increase in length.

Microscopical Findings. The specimen shows a thick layer of fibrous tissue over the end of the bone, and a slight tendency of ingrowth of cartilage at the periphery. The remainder of the epiphysis, the epiphyseal cartilage plate, the metaphysis, and the diaphysis appear normal.

Experiment 48. 16 Days. Dog 65-58.

Operation. Removed the portion of the epiphysis of the metatarsal IV. of the right hind foot distal to the epiphyseal cartilage plate. The part remaining measures 2.1 cm. The animal died at the end of 16 days.

Gross Findings. There is good healing. The cut end appears roughened. The measurement of the operated bone is 2.2, showing that no growth has taken place.

Experiment 49. 62 Days. Dog 124-77.

Operation. Removed the greater part of the epiphysis of the metacarpal III. of the left forefoot. The part remaining is 2.4 cm. in length, while the total length is 2.9 cm. The animal died at the end of 62 days.

Gross Findings. The cut end is healed over but there is no new joint cavity. On section there does not appear to be any increase in size of the epiphysis. The epiphyseal cartilage plate appears normal, as does the remainder of the bone. There is a growth of 3.05—2.4= 0.65 cm. in the operated bone, while the normal growth is 3.7—2.9=0.8 cm.

Microscopical Findings. The cut end is covered by fibrous tissue which, in places, has a hyaline-like appearance. There is no definite evidence of new articular cartilage. The remainder of the bone, including the marrow and trabeculae of the epiphysis, is normal.

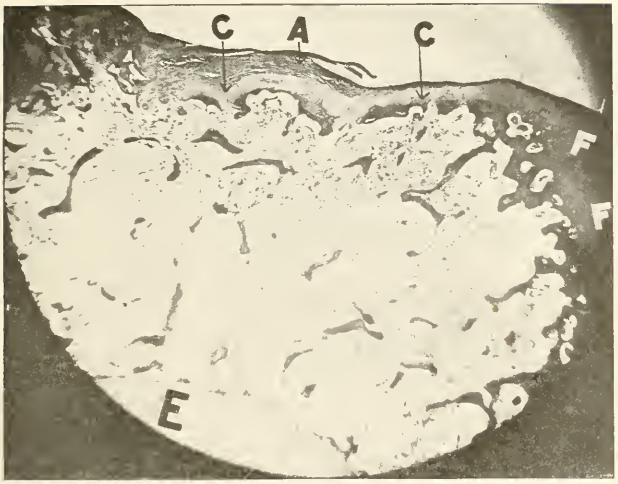


FIG. 6.—Experiment 50. 67 days. Dog 102-69. Cutting across the epiphysis and removing the articular end of the bone. The cut end of the bone is enclosed by new tissue that appears somewhat like an articular surface. On the outside there is a layer of fibrous tissue within which there is a layer of new cartilage. The origin of this new cartilage can not be definitely determined. A portion appears to be extending in from original cartilage that connects the articular cartilage with the epiphyseal cartilage plate, FF. Some of the cartilage is closely connected with the bone trabeculae from which it might take origin. Another source of origin could be from the connective tissue through a process of metaplasia. A, outer layer of fibrous tissue; C,C, inner layer of new cartilage; F,F, original cartilage connecting the articular cartilage with the epiphyseal cartilage plate; E, epiphyseal cartilage plate (just on the edge of the field and out of focus). Microphotograph. Objective 2/3. Ocular 2 inch B. and L.

Experiment 50. 67 Days. Dog 102-69.

Operation. Removed the epiphysis distal to the epiphyseal cartilage plate of metacarpal III. of the right forefoot. The total length of the bone is 2.65 cm. The length after removal of the epiphysis is 2.15 cm. The animal died at the end of 67 days.

Gross Findings. There is good healing. The cut end of the bone is rounded off, and appears to be covered with a thin layer of cartilage. The epiphyseal cartilage plate appears normal and bears the

same relative position to the end of the bone that it did at the time of the operation. The remainder of the bone appears normal. The measurements are: Metacarpal III.=3.2 cm.; at the time of operation, 2.15 cm.; amount of growth, 1.05 cm. Metacarpal IV.=3.95 cm.; at time of operation, 2.65 cm.; amount of growth, 1.30 cm. Thus there is almost as much growth in the operated bone as in the normal bone.

Microscopical Findings. The cut end of the bone presents an interesting microscopical picture. Near either border there appears to be a definite ingrowth of cartilage from the remains of portions of the lateral aspect of the articular cartilage. The cut end is surrounded by a dense mass of fibrous tissue; on the inner side of this, near the cut end of the bone, there are areas of young cartilage cells and osteoid tissue. These new masses of cartilage cells and osteoid tissue might be formed by a metaplasia of the fibrous tissue. However, they bear close relationship to the trabeculae of the epiphysis, which seems to be the more likely source of this new tissue. There seems to be a definite attempt to reëstablish a new articular surface (Fig. 6). The remainder of the epiphysis appears normal. The epiphyseal cartilage plate has a fairly normal structure. The metaphysis and diaphysis are normal.

SUMMARY ON REMOVAL OF THE GREATER PART OF THE EPIPHYSIS.

There is practically no disturbance in growth or structure of the epiphyseal cartilage plate.

There appears to be a definite tendency to form a new articular surface of cartilage and osteoid tissue after removal of the entire end of the bone.

TABLE XIII.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
46	27-56	1 day	0	0	0
47	28-73	9 days	0	0	0
48	65-58	16 "	0.2 cm.	0.2 cm.	0.4 cm.
49	124-77	62 "	0.15 cm.	0.61 cm.	0.8 cm.
50	102-67	67 "	0.25 cm.	1.05 cm.	1.3 cm.

2. Removal of the Entire Epiphysis up to the Metaphysis.

Method. After exposing the bone an incision is made through the perichondrium about the epiphyseal cartilage plate and a separation produced in the line of cleavage. The distal epiphyseal fragment containing the epiphyseal cartilage plate is then removed. The wound is closed as usual.

Experiment 51. 9 Days. Dog 29-73.

Operation. Removed the entire epiphysis of the metacarpal IV. of the right forefoot. The total length of the bone is 2.5, the part remaining is 1.9 cm. The animal died at the end of 9 days.

Gross Findings. There is a layer of fibrous tissue enclosing the end of the bone, but no evidence of change in the bone.

Microscopical Findings. There is a thick layer of fibrous tissue surrounding the end of the bone. The thin layer of cartilage that covers the metaphysis is absent, as are the cartilage buds of the metaphysis. The remainder of the bone appears normal.

Experiment 52. 22 Days. Dog 148-86.

Operation. Removed the entire epiphysis after separating in the natural cleavage plane. The total length of the bone is 2.8 cm., while the piece remaining is 2.2 cm. The animal died at the end of 22 days.

Gross Findings. There is good healing. The end of the bone is encapsulated with fibrous tissue. There is very little evidence of bone proliferation except on the plantar surface. The Roentgenogram shows the loss in growth, as is noticed by a comparison of the diaphysis of operated and normal bone. (See Fig. 4.) The measurements are: Metacarpal IV., at autopsy, 2.3 cm.; metacarpal IV., at operation, 2.2 cm.; amount of growth, 0.1 cm. Thus there has been practically no growth since the operation. The normal growth is 3.4—2.8=0.6 cm.

Experiment 53. 62 Days. Cat 59-48.

Operation. Removed the epiphysis of the metatarsal III. of the right hind foot. The part remaining measures 2.2 cm. The animal died at the end of 62 days.

Gross Fidings. There is good healing. There appears to be a slight outgrowth at the end of the bone. The measurements are: Metatarsal III., at autopsy, 2.3 cm.; metatarsal III., at operation, 2.2 cm.; amount of growth, 0.1 cm. Thus there is but 0.1 cm. of growth. The normal growth is at least 1.3 cm.

Microscopical Findings. The end of the bone is encapsulated in fibrous tissue. There is no evidence of metaphyseal cartilage buds, only some heavy osseous trabeculae being present. At one border of the bone there is a proliferation of cartilaginous tissue from the osseous tissue which has taken on an arrangement similar to that of the articular cartilage. The remainder of the bone appears normal.

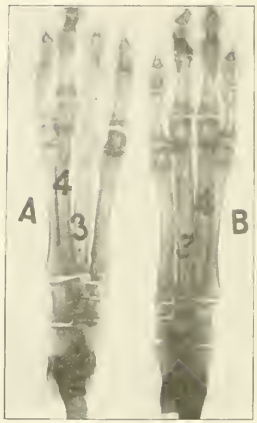


FIG. 7.—Experiment 54. 68 days. Dog 120-75. Removal of entire epiphysis. The removal of the epiphysis of 3A is complete. There is a marked hindrance in growth that can easily be ascertained by comparing the diaphysis of 3 and 4 of A, which are normally equal. The shadows at the distal ends that might be mistaken for portions of the epiphysis are sesamoid bones. The shaft of the bone is irregular and rarefied.

Experiment 54. 68 Days. Dog 120-75.

Operation. Removed the epiphysis of the metatarsal III. of the right hind foot. The total length of the bone is 3.45 cm. and the portion remaining is 2.75 cm. The animal died in 68 days.

Gross Findings There is good healing. There is practically no evidence of growth. On longitudinal section the cut end is found to be encapsulated by fibrous tissue. There is no evidence of epiphyseal cartilage. The marrow appears normal. The Roentgenogram shows the marked shortening, the slight irregular bone proliferation, and the rarefactions of the shaft. (See Fig. 7.) The measurements are: Metatarsal III., at autopsy, 3.0 cm.; metatarsal III., at operation, 2.75 cm.; amount of growth, 0.25 cm. Thus there has been but 0.25 cm. of growth since the operation. The normal growth has been 4.65—2.75=1.9 cm. So that here has been practically a complete cessation of growth since the operation.

Microscopical Findings. The cut end of the bone is surrounded by dense fibrous tissue. There is still the remnant of metaphyseal cartilage covering the bone end. In some places there are irregular columns of cartilage resembling the epiphyseal cartilage columns. These might be the remains of the original columns. Whatever proliferation has taken place is of a purposeless nature.

Experiment 55. 81 Days. Dog 19-53.

Operation. Removed the epiphysis of the metatarsal IV. of the left hind foot. The length of the bone after removal of this piece is 2.25 cm. The total length of the normal bone is 2.8 cm. The animal was killed by illuminating gas at the end of 81 days.

Gross Findings. There is a sort of new joint composed of fibrous tissue about the cut end, allowing a certain amount of mobility. On longitudinal section the end of the bone is found to be covered by a mass of fibrous tissue 1.5 cm. thick. There is a white band that looks like the remains of the epiphyseal cartilage plate. The remainder of the bone appears normal. The Roentgenogram shows the shortening and lack of proliferation, which can easily be made out by comparing the diaphysis of the operated with the normal bone. The measurements are: Metatarsal IV., at autopsy, 2.85 cm.; metatarsal IV., at operation, 2.25 cm.; increase in length, 0.60 cm. Thus there is an increase of 0.60 cm. in length since the operation. The normal increase is 5.05—2.8=2.25 cm.

Experiment 56. 126 Days. Dog 89-64.

Operation. Removed the epiphysis of the metatarsal III. of the right hind foot. The piece remaining measures 2.0 cm. The animal was killed with chloroform at the end of 126 days.

Gross Findings. There is good healing. The end of the bone is pointed and surrounded by dense fibrous tissue. The Roentgenogram shows the entire distal end of the bone narrower than normal. The cut surface is irregular. The diaphysis of metatarsal III. is shorter than the diaphysis of metatarsal II., whereas normally it is much longer. (See Fig. 8.) The measurements are as follows: Right metatarsal III., at autopsy, 2.9 cm.; right metatarsal III., at operation, 2.0 cm.; increase in length, 0.9 cm. Thus there is an increase of 0.9 cm in the length of the operated bone. This is irregular and pointed, like an outgrowth of bone along a strip of periosteum. The normal growth during this time was over 2.0 cm.

FIG. 8.—Experiment 56. 126 days. Dog 90-64. Removal of the epiphysis. The second bone from the right, 3, is the operated bone. There is a slight irregular growth from the cut end, which is not like the purposeful growth that occurs at the normal epiphyseal cartilage plate. Notice that it is shorter than the first bone on the right while normaly it is longer.

Experiment 59. 126 days. Dog 90-64. Cutting across the bone proximal to the metaphysis and removing the entire distal segment including the epiphysis. The second bone from the left, 4, is the operated bone. There has been an outgrowth of bone from the cut end, but it is pointed and thinner than normal. It is not like the purposeful growth that takes place from normal epiphyseal cartilage plate.

SUMMARY ON REMOVING ENTIRE EPIPHYSIS UP TO THE METAPHYSIS.

In these six experiments there are only two instances in which there is any appreciable increase in length. In these particular cases the growth is irregular and not like that which takes place in length growth in the epiphyseal cartilage plate. Thus it can be concluded that after removing the epiphysis there will be a failure of length growth of the remaining portion of the bone.

There is a certain tendency to encapsulate the cut bone end with tissue not unlike the articular cartilage.

TABLE XIV.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
51	29-73	9 days	?	——	——
52	148-86	22 "	0.5 cm.	0.1 cm.	0.6 cm.
53	59-48	62 "	1.1 cm.	0.1 cm.	1.2 cm.
54	120-75	68 "	1.65 cm.	0.25 cm.	1.9 cm.
55	19-53	81 "	1.65 cm.	0.60 cm.	2.25 cm.
56	89-64	126 "	1.10 cm.	0.9 cm.	2.0 cm.

3. Cross Incision Through the Metaphysis and the Diaphysis with Removal of the Distal Fragment.

Method. After exposure of the bone a cross incision is made through the metaphysis or adjoining part of the bone and the entire distal segment is removed and not replaced.

Experiment 57. 16 Days. Dog 66-58.

Operation. Made an incision just proximal to the metaphysis and removed the distal portion of the metatarsal III. of the right hind foot. The part remaining measures 1.95 cm. The animal died at the end of 16 days.

Gross Findings. The healing is not very good. The end of the bone appears dry. The measurements are as follows: Metatarsal III., at autopsy, 2.2 cm.; metatarsal III., at operation, 1.95 cm. Thus there is 0.25 cm. increase in length.

Experiment 58. 67 Days. Dog 103-69.

Operation. Cut through the metatarsal III. of the left hind foot just proximal to the metaphysis and removed the distal segment. The total length is 2.85 cm., while the portion after removal measures 1.9 cm. The animal died at the end of 67 days.

Gross Findings. There is good healing. There is a pointed outgrowth of bone at the severed end. Upon longitudinal section the end is found to be covered with fibrous tissue. The cortex is found to extend beyond the narrow cavity on each side, thus giving the end a concave shape. The remainder of the bone is normal. The measurements are as follows: Metatarsal III., at end of experiment, 2.35 cm., metatarsal III., at operation, 1.9 cm. Thus there is 0.45 cm. increase in length of the bone, which is mostly in the nature of a proliferation of the cortex. The normal increase is 4.2—2.85=1.35 cm.

Microscopical Findings. The articular end of the bone is surrounded by dense fibrous tissue. The cortex has become pointed in this region, and at the tip there is a mass of young cartilage tissue, again showing the tendency to encapsulate the cut end with cartilage. The cartilage cells from this tissue seem to have originated from the osseous trabeculae near the cut end. The fibrous tissue adjacent to the cartilage cells suggest somewhat the changes that take place in membraneous bone formation.

Experiment 59. 126 Days. Dog 90-64.

Operation. Cut across the metatarsal IV. of the right hind foot just proximal to metaphyseal region. Then removed the distal segment and did not replace. The portion remaining measured 1.85 cm. The animal was killed by chloroform at the end of 126 days.

Gross Findings. There is good healing. The end of the bone is covered with fibrous tissue. There has been an outgrowth of bone which is thinner than normal and pointed. The Roentgenogram shows the pointed outgrowth of bone and the general narrowing of the remainder of the bone. (See Fig. 8.) The measurements are: Metatarsal IV., at the end of experiment, 3.0 cm.; metatarsal IV., at operation, 1.85 cm. There has been 1.15 cm. of growth since the operation. This is of a pointed nature and possesses none or little marrow. It is an outgrowth of bone such as may occur upon the severed end of any bone and is not the definite longitudinal growth that takes place about the epiphyseal cartilage plate. The normal growth of bone has been about 1.5 cm.

SUMMARY ON CUTTING THROUGH PROXIMAL TO METAPHYSIS WITH REMOVAL OF THE DISTAL FRAGMENT.

After the removal of the distal segment of bone there is an outgrowth of bone from the cut end. This outgrowth is not like that occurring in the region of the epiphyseal cartilage plate as there is an entire lacking of the corresponding addition of the marrow cavity. It is more than likely that this outgrowth is like that which takes place along a periosteal remnant or that takes place in the region of the cut end of any young actively growing bone.

TABLE XV.

Exp. No.	Dog No.	Duration	Loss of Growth	Growth of Operated	Growth of Normal
57	66-58	16 days	0	0.25 cm.	0
58	103-69	67 "	0.9 cm.	0.45 cm.†	1.35 cm.
59	90-64	126 "	0.4 cm.	1.15 cm.†	1.5 cm.

† Pointed.

GROUP VI. CROSS INCISION WITH REMOVAL OF THE PROXIMAL SEGMENT.

1. Through the Line of Cleavage of the Epiphyseal Cartilage Plate.

Method. The periosteum is cut about the epiphyseal cartilage plate and the epiphysis is separated in the line of cleavage. The proximal segment is then removed, leaving only the epiphyseal end of bone, including the epiphyseal cartilage plate.

Experiment 60. 30 Days. Cat 73-47.

Operation. Removed all but the epiphysis of metacarpal IV. of the left fore foot. The segment remaining measured about 0.5 cm. The animal died at the end of 30 days.

Gross Findings. There is good healing. The measurement of the operated bone was lost but from the general findings it can be presumed that there was no growth.

Experiment 61. 33 Days. Dog 113-73.

Operation. Separated at the natural line of cleavage after first incising the periosteum about the epiphyseal cartilage plate of metacarpal III. of the right fore foot. Then removed the entire basal portion. The total length of the bone is 1.9 cm., while the part remaining is .8 cm. The animal died at the end of 33 days.

Gross Findings. There is good healing. On longitudinal section a conical outgrowth of osseous tissue is found upon the free end of the bone. The epiphyseal cartilage plate is intact and is situated within this newly formed bone. The measurements are: Metacarpal III., at end of experiment, 0.85 cm.; metacarpal III., at operation, 0.8 cm. Thus, from the measurements, there is no evidence of increase in length. The normal increase in length is 3.0 cm—1.9 cm.=1.1 cm.

Microscopical Findings. The articular cartilage marrow and trabeculae of epiphysis appear normal. The epiphyseal cartilage plate is narrower than normal but has a fairly normal histological structure. There has been some separating of the bone in the metaphyseal region where there are ossifying cartilaginous columns which are lacking in some of the normal structure. The marrow is scanty. There has been some proliferative changes but not of the marked degree of the normal The growth is pointed and purposeless. (Fig. 9.)

Experiment 62. 44 Days. Dog 98-60.

Operation. The entire proximal end of the metacarpal III. of the right fore foot is removed up to the epiphyseal cartilage plate. The portion remaining measures 0.5 cm. The animal died at the termination of 44 days.

Gross Findings. The healing is good. The segment of bone crumbles somewhat upon making a longitudinal incision. Some of the epiphyseal cartilage plate is still present but the greater part can not be made out.

FIG. 9. Experiment 61. 33 days. Dog 113-73. Separation in the line of cleavage with removal of the entire basal portion of the bone, leaving the epiphysis. The microphotograph shows the irregular pointed outgrowth of bone that has taken place from the region of the epiphyseal cartilage plate. There is no evidence of a limiting cortex and the growth is of a purposeless nature. EE is the border of the epiphyseal cartilage plate (the remainder of the epiphysis could not be shown in the field); B, the pointed extremity of the new bone.

Microphotograph. Objective 1 inch. Ocular 2 inches. B. and L.

Experiment 63. 62 Days. Dog 125-75.

Operation. Removed the proximal portion of the metatarsal III. of the right hind foot. The entire length of the bone is 3.0 cm., while the part remaining is 0.7 cm. The animal died in 62 days.

Gross Findings There is a slight outgrowth from the epiphyseal cartilage plate. The epiphyseal cartilage plate appears normal. The

remainder of the bone appears normal. The measurements are: Right metatarsal III., at end of experiment, 0.8 cm.; right metatarsal III. at operation 0.7 cm. Thus there is practically no growth of the operated bone. The normal growth is 1.0 cm.

SUMMARY OF REMOVING THE PROXIMAL END OF BONE UP TO THE EPIPHYSEAL CARTILAGE PLATE.

There has been practically a complete cessation of growth in all the experiments after such a procedure. The entire epiphyseal cartilage plate was left remaining, but growth ceased in spite of that fact. This failure of function of the epiphyseal plate can be ascribed to the great destruction of its direct blood supply, to injury to some of the cartilage cells, and loss of normal medium for the budding of the new cartilage columns.

TABLE XVI.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
60	73-47*	30 days	——	——	——
61	113-73	33 "	1.05 cm.	0.5 cm.	1.1 cm.
62	98-60	41 "	0.85 cm.	0.15 cm.	1.0 cm.
63	125-75	62 "	0.9 cm.	0	1.0 cm.†

*Cat
†Estimated

2. Through the Metaphysis or Diaphysis.

Method. An incision is made across the metaphysis or diaphysis and the proximal fragment is removed.

Experiment 64. 15 Days. Cat 76-5.

Operation. Cut across the metaphyseal region of the metatarsal III. of the right hind foot and then removed the entire proximal piece. The part remaining measured 0.85 cm. The animal died at the end of 15 days.

Gross Findings. The healing is good. The measurements are: Metatarsal III., at end of experiment, 0.9 cm.; metatarsal III., at operation, 0.85 cm.=0.05 cm. Thus there has been no growth since the operation.

(To be continued.)

Society Meeting.

SECTION IN ORTHOPEDIC SURGERY

NEW YORK ACADEMY OF MEDICINE

17-21 WEST 43RD STREET

CLINICAL MEETING IN CHARGE OF

THE NEW YORK HOSPITAL FOR RUPTURED AND CRIPPLED

Friday Evening, February 21st, 1919, at 8.30 o'clock sharp

ORDER

I. READING OF THE MINUTES.

II. PRESENTATION OF PATIENTS.

a. 1. Operative correction for deformity of the femur following fracture.
2. Operative correction for deformity of the radius following fracture.
Virgil P. Gibney, M.D.

b. 1. Operative treatment of pathologic dislocattion of the patella.
Royal Whitman, M.D.

c. 1. Operation for removal of fractured internal condyle of the humerus.
2. Operative correction for outward congenital dislocation of patella.
Henry Ling Taylor, M.D.

d. 1. Mild spasticity due to intracranial hemorrhage in adult; decompression; improvement. William Sharpe, M.D.

e. 1. Fracture of the humerus
2. Fracture of the tibia and fibula.
Charlton Wallace, M.D.

f. 1. Presentation of orthopædic case. B. H. Whitbeck, M.D.

g. 1. Fracture of the spine.
2. Genu recurvatum and knock knees in adult, cured by operation.
Samuel Kleinberg, M.D.

h. 1. Fracture dislocation of elbow. W. L. Sneed, M.D.

i. 1. Presentation of cases of anterior poliomyelitis.
William Frieder, M.D.

j. 1. Lantern demonstration of bone lesions. P. Ashley (by invitation.)

k. 1. Resection of right elbow of adult for ankylosis in bad position.
George Barrie, M.D.

III. DISCUSSION.

REGINALD H. SAYRE, M.D., *Chairman*
14 West 48th Street

GEORGE BARRIE, *Secretary*
15 East 48th Street

Notice.

TO THE MEMBERS OF THE AMERICAN ORTHOPEDIC ASSOCIATION:—

Dr. H. Augustus Wilson, the representative of the American Orthopedic Association on the Committee of Arrangements of the Congress of Physicians and Surgeons, announces that the Annual Meeting of the Association will be held in Atlantic City on Monday and Tuesday, June 16 and 17, 1919, directly following the meeting of the American Medical Association. The Hotel Chalfonte will be the headquarters for both meetings.

Members should make early reservation of rooms.

Current Orthopaedic Literature

Numerals at head of each abstract are for use in connection with the official "Classification of Orthopædic Literature," published in the JOURNAL for January, 1917, reprints of which are obtainable from the JOURNAL office.

III. ORTHOPAEDIC OPERATIVE, POST OPERATIVE AND ADJUVANT TECHNIC.

III, 3, b.

NEW OPERATION FOR SUBSTITUTION OF THE THUMB. J. L. Joyce. *British Journal of Surgery*, April, 1918.

The author advises substitution of the ring finger of the opposite hand for the thumb lost as a result of injury or disease and he uses a new method of applying a pedunculated flap. The steps of the operation are briefly the following:

1. Preparation of the bed for the reception of the new metacarpal bone and exposure of the proximal end of the divided tendon of the old thumb.
2. Dislocation of the ring finger of the opposite hand at the metacarpal phalangeal joint, with division of the soft tissue at the base of the radial side of the proximal phalanx, division of the extensor and flexor tendon and the preservation of the nutritive flap on the ulnar side of the finger.
3. Fixation of the new metacarpal bone (proximal phalanx of the ring finger) in its bed, union of the tendon and nerve, suture of the incision and fixation of the hand.
4. Division of the nutritive flap two months later.

All these steps are more minutely described and the end result of the case is given in a number of photographs. Aside from the fact that the cosmetic result is extremely gratifying, the functional result obtained, as illustrated by photographs, is nothing less than astounding and it is safe to say that this case is the most remarkable one reported in literature on thumb plasty from Nicoladoni to the present time.—*A. Steindler, Iowa City, Ia.*

III, 7.

AUTOPLASTIC NERVE TRANSPLANTATION IN THE REPAIR OF GUNSHOT INJURIES. By Leo Mayer. *Surg. Gynec. & Obstet.*, November, 1918.

The author describes a method of bridging nerve gaps with autogenous sensory nerve. The scar tissue about the injured nerve is dissected away, the length of gap noted, then the external saphenous vein is exposed, and in intimate association with it is found the external saphenous nerve. If the injured nerve is 4 times the diameter of the external saphenous nerve, enough external saphenous nerve is dissected out to furnish a four strand cable approximately the diameter of the injured nerve. The nerve is held in a special Bunnell clamp (S. S. White matrix steel gouge .003). A single stitch holds the four strands of the cable together. Fine silk sutures hold each strand of the cable at each end to the abutting ends of the injured nerve.

The advantages of the transplantation method are:

1. There is no excessive tension on the line of suture.
2. Immobilization of the limb in a flexed position, with subsequent stretching, is not necessary.

3. The technique, when practiced, is by no means difficult.
4. The clinical results are superior, in the author's opinion, to any other form of nerve bridging operation.—*Leo C. Donnelly, Detroit.*

III, 12.

Self Retaining Retractor for Use With Albee Bone Outfit. Lowman and Pratt. *Surg., Gynec. and Obstet.* Dec., 1918.

The retractor is made of two arcs of spring steel fixed together by lateral lips. The toothed portions are rounded and broad, giving wide, even retraction. The retractor encircles the limb, the weight of the limb produces the retraction. The lateral lips furnish a simple friction lock whose function is increased by any force exerted upon the two parts of the retractor, except exactly in the direction of its arc by means of which the retractor is opened and closed.

Advantages are simplicity, durability, cheapness, produces retraction and depression, does away with an assistant, keeps extra hands out of the wound, leaves bone in higher plane than surrounding tissue, lessens danger of motor entangling in towels, gives a better exposure, also removes one assistant, allowing clinic to see better.—*Leo C. Donnelly, Detroit.*

IV. RESEARCH IN BONE GROWTH AND REGENERATION. SKELETAL ANATOMY AND PHYSIOLOGY.

A Study of the Development of the Epiphysis. By Philip H. Kreuscher. *Surg., Gynec. and Obstet.* Nov., 1918.

In the early periods of bone development the epiphysis is entirely cartilaginous; later there is a gradual disappearance of the cartilage until only a shell remains, surrounding the cancellous epiphyseal bone and marrow. The cartilage at one end persists to form the articular cartilage, while at the inner boundary if forms a part of the epiphyseal cartilage line. The epiphyseal cartilage line ceases to functionate, either when transplanted by itself, or with a small or large piece of adjoining bone, or even transplanted as an entire bone. The loss of growth probably is due to the interference with the vascular supply from the diaphyses to the epiphyseal cartilage line.

A center of ossification in the distal epiphysis of the femur is nearly constant at birth, the four parts of the occipital bone are separate, the mastoid portion of the temporal is partially ossified, the lateral halves of frontal still separate at birth. The vertebrae are ossified in all essential parts, but epiphyses still separated by cartilage. In some cases the proximal epiphysis of humerus is ossified at birth, center for external condyle at thirteenth to fourteenth year, for external epicondyle 8th to 10th, internal condyle 5th to 6th, internal epicondyle 8th to 10th. The metacarpal and phalangeal bones are ossified at birth, cuneiform appears at third year, trapezium and semilunar at 5th, scaphoid at 6th, trapezoid at 8th, pisiform at 12th. At birth the ossified portion of os pubis usually surrounds only a portion of anterior boundary of obturator foramen; symphysis and upper portion of horizontal ramus remain cartilaginous.

No ossification centers are present at birth in the upper end of the femur, the one for the head coming during the first year, great trochanter at third year, lesser trochanter 13th to 14th year. The centers for the proximal epiphyses of tibia, fibula, cuboid and 3 cuneiforms usually are not present at birth.

The os calcis develops by a single center appearing at 6th month of foetal life, the center for the epiphysis at 9th year. The astragalus at 7th month,

cuboid at 9th, external cuneiform 1st year, internal at 3rd year, middle cuneiform and scaphoid at 4th year. Growth and development is influenced largely by the health of the mother and foetus; syphilis, rickets, osteogenesis imperfecta, etc., retarding.

Conclusions.

1. That a thorough knowledge of the normal structures and their time of appearance is necessary intelligently to treat the abnormal conditions.

2. That fractures at the epiphyseal lines should be recognized early and reduced completely to avoid deformities.

3. That injuries about the joints in the young must never be treated lightly or haphazardly.

4. That operative injury of the epiphyseal line is inexcusable with our present knowledge of its importance.—*Leo C. Donnelly, Detroit.*

V. TUBERCULOSIS.

V, 2, *a*.

Tuberculous Disease of the Hip Joint. H. J. Gauvain. *The Lancet.* November 16, 1918.

The author describes a sign which is significant in determining activity in apparently quiescent cases of hip disease. If the femur is grasped firmly in the region of the condyle it may be gently rotated within the acetabulum inward and outward to a definite degree. If this range of motion is exceeded passively it results instantly in spasmodic muscular contractions not confined to muscles about the joint but extending to the abdominal muscles. Quite a gentle and painless sharp rotary movement is sufficient to provoke this reflex spasm of the abductor muscles. The value of the sign lies in the fact that without such definite indication of activity ambulatory treatment may be permitted too early with great risk of relapse.

While failure to elicit the sign is a certain indication that there is no muscular spasm about the affected joint, that alone does not justify assumption that disease is finally arrested. If recumbency and immobilization are enforced and the sign of activity described cannot be demonstrated, not only may a favorable prognosis be given in general, but also a very useful range of movement in the joint attacked may be anticipated.

The sign also has diagnostic significance in early cases of tuberculous hip disease. It is one of the many signs of tuberculosis, but it affords confirmative evidence of active inflammation about the hip joint, in conjunction with other signs of tubercular disease of the hip.—*A. Steindler, Iowa City, Ia.*

X. CONGENITAL ABNORMALITIES (other than dislocations.)

X, 2, and XVIII, 2.

Common Lesions Producing Backache. Wm. F. Shackleton. *Surg., Gynec. and Obstet.* December, 1918.

The author briefly reviews the classification of lesions of the lumbo-sacral and sacro-iliac joints. He has carefully dissected this region in 26 cadavers. The one constant finding was that the lumbo-sacral cord directly overlies the linea innominata and that it is not protected by underlying soft parts. The transverse process of the last lumbar vertebra varies in length from ½ cm. to 4 cm., and in shape from a rounded point to a broad fish-tail process. The distance between the processes and the ilium varies from fusion to 6 cm. The anomalies of the processes which become pathological seem to develop during years of hard labor. The factors involved in the

production of pain seem to vary. The transverse process may impinge on the ilium, and acting as a fulcrum, separate the sacro-iliac joint. Hyperplasia of the soft parts may involve the nerve or the process may act as a cervical rib on the brachial plexus.

Treatment resolves into constitutional, palliative, and radical surgical procedures. In chronic conditions, belts, girdles, corsets and casts bear practically the same relation in the treatment of these cases that the application of a truss bears to hernias.—*Leo C. Donnelly, Detroit.*

XI. ACUTE INFECTIONS OF JOINTS AND BURSAE.

XI, 1.

Laceration and Infection of Joints in Children. A. Mitchell. *British Journal of Children's Diseases.* July—September, 1918.

The author emphasizes the importance of this class of cases and the unsatisfactory results of treatment. He stresses the following points in treatment:—Complete immobilization with extension, excision of all infected tissue including synovial membrane in the wound tract, the removal of foreign bodies, and the washing out of all debris and clots with a weak antiseptic or salt solution. The drainage tube and the Bipp dressing are recommended. Histories of three cases with complete functional results are given. The use of the Robert Jones splints and plaster of Paris for fixation is recommended. The joints are fixed for about a month after the wounds are healed. Passive motion and massage followed.—*Edward Z. Holt, Atlantic City.*

XII. CHRONIC INFECTIONS OF JOINTS AND BURSAE (non-traumatic).

XII, 3 *a*.

Typhoid Spine. Sir Wm. Osler *Bulletin of Canadian Army Med. Corps.* September, 1918.

Sapper C, paralyzed for nearly two years, yet he walked in ten minutes. What a case for Lourdes or for our own Canadian St. Anne de Beaupré.

In February, 1916, Sapper C had an ordinary attack of typhoid fever. Convalescence was slow. In October he began to complain of pain in the back, and stiffness. From that time he became progressively incapacitated, was never out of bed for two years.

On examination patient showed excessive nervousness and apprehension.—fearful lest he be moved,—well nourished, no mental disturbance, pupils widely dilated. When stripped a profuse blush covered the body and an unusually persistent goose skin. Any attempt to move caused agonizing pain in the back. Legs looked normal, no wasting, no disturbance of sensation. Spine was straight, there was no projection or prominence. Pressure was exceedingly painful below the mid-dorsal and lumbar spine. Toes could be moved and ankles flexed.

Sensation. A band of extreme hyperæsthesia extended around the body a hand's-breadth wide below the costal margin,—more marked in front.

Reflexes. Knee jerks exaggerated. Nothing else of note. X-ray plates showed a spine normal in every particular.

In May, 1917, Sapper C. was transferred to the Duchess of Connaught Hospital at Cliveden. Here a spinal jacket gave great relief from the pain and the general condition was much improved, but it was found impossible to get the patient to sit up, and every attempt at moving the legs brought

on a clonic spasm. After eight months he was transferred to National Hospital, Queen's Square, London, to the care of Dr. Yealland, C.A.M.C., formerly of the Out-patient Psychopathic Department of the Toronto General Hospital.

Dr. Osler goes on to discuss his former opinion that typhoid spine was always a functional neurosis, but states that he changed his mind on seeing a case with Dr. Runhardt in 1902, when there was well marked and painful swelling just above the sacro-iliac articulation, though no suppuration followed. A number of other cases are referred to where examination and x-ray pictures have shown the usual signs of a definite spondylitis.

In support of the view that typhoid spine is essentially a neurosis, Dr Osler cites a case shown at Johns Hopkins Medical Society in 1901, emphasizing the following features. First, a state of neurasthenia with vasomotor changes and often the definite stigmata of hysteria. Secondly, stiffness of the back persisting for weeks or months, associated with pain, often of an agonizing character. Third, pain on pressure over certain spinous processes. Fourth, a negative local examination. Lastly, a prompt recovery with the use of the Paquelin cautery and measures directed to the neurotic condition.

The case of Sapper C. strongly supports this view. After the spinal jacket was removed, still very neurotic, spine absolutely rigid, he could not be induced to move or sit up; but new surroundings, a new mind and very skillfully applied methods did in ten minutes what a year's treatment failed to do—put him on his feet, walking well, looking well and very happy to be so.

Cases of typhoid spine may be grouped in three categories: First, those in which the hysterical features predominate; secondly, cases with fever, pain, rigidity, and evidence of nerve root involvement; and thirdly, a group of cases with definite objective changes in the spine, as shown by x-ray pictures as well as by examination.—*F. P. Yorston, Montreal.*

XII, 6.

Case of Loose Body in Knee Joint. P. B. Roth. *Lancet.* September 28, 1918.

A Jones operation followed a typical history of a loose body in the knee joint. The body was removed. A subsequent X-ray showed another shadow posterior to that caused by the loose body. This proved to be a sesamoid bone in the gastrocnemius. The author differentiates between a loose body in the knee joint and a sesamoid in the gastrocnemius. A sesamoid when seen from the side is oval shaped, with its long axis placed vertically. It is as dense to X-rays as is the densest part of the femur and is situated behind a line joining the most posterior portion of the tibial head and the femoral condyles. This paper is extremely interesting.—*Edward Z. Holt, Atlantic City.*

XIV. PARALYTIC CONDITIONS.

XIV, 3.

Cerebral Spastic Paralysis. M. E. Blahd, and Walter G. Stern. *American Medical Association Journal.* November 2, 1918.

This paper gives a brief but very complete recital upon the subject of cerebral spastic paralysis from the etiology to the treatment. All cerebral lesions, such as clots, tumors or cysts, should be attacked early if any result is to be expected. Cases of long standing or very extreme involvement do not hold out hope of much improvement by intra-cranial interference.

Resection of the posterior nerve roots has been very beneficial in many cases. This relieves the spastic component and allows the paralytic component to be improved by education. The possibility of nerve regeneration, and so a bridging of the gap, must be taken into consideration. Forcible correction of deformities is sometimes useful, but often very painful to passive motion afterward.

Tenotomy may be employed, but lengthening of the tendon is better, because the balance of opposing groups of muscles is thereby much more certain. Tenotomy with too great an over-correction is most often a disappointing failure.

By far the most important part of the treatment is the education which must follow operative procedures. This should be followed carefully for many years under competent supervision. Systematic muscle training as well as vocational practice in schools established for the purpose are advised.—*Harold A. Pingree, Portland, Me.*

XVI. METABOLIC DISEASES AND DISEASES OF INTERNAL SECRETION.

XVI, 8.

Osteitis Deformans; Report of Two Cases. S. R. Leahy. *Neurological Bulletin.* August, 1918.

The author reviews the history of osteitis deformans and presents elaborate histories of two cases. He believes Paget's disease to be due to a disturbance of the secretions of the endocrinous glands. The condition differs from acromegaly chiefly in that the bones of the face, hands, and feet are not affected. The skull does not show the marked thickening in acromegaly that is so characteristic of this disease. An extensive bibliography accompanies the article. *Edward Z. Holt, Atlantic City.*

XVIII. STATIC OR POSTURAL DEFECTS.

XVIII, 6.

Static Defects of the Feet. Edward A. Rich. *American Medical Association Journal.* December 14, 1918.

Major Rich advocates the use of certain set measures for determining the condition of the arches of the foot itself as well as the relation of the leg to the foot through the medium of the ankle joint. He uses the Feiss scaphoid scale to ascertain the elevation of that bone. This scale corresponds to Feiss's line and determines whether the internal arch is too high, too low, or just about normal

The second means is a map of the weight-bearing foot by means of an ink impression which gives us the bearing surface, and this is combined with a pencilled outline which shows us the degree of pronation as well as the extent to which valgus of the ankle has taken place. By means of these planes we are enabled to judge the type of foot disability as well as its extent. The weight must be carried on that part of the foot by which nature intended it should be borne.

These changes are accomplished by the insertion of variously shaped leather wedges between the layers of the boot sole. The cardinal points are few and simple.

Major Rich's years of civil practice, as well as his large experience in the army, seem to justify a consideration of his opinion. The article is furnished with many excellent illustrations.—*Harold A. Pingree, Portland, Me.*

Vol. I, No. 4 APRIL, 1919 Old Series: Vol. xvii, No. 4

The Journal of Orthopædic Surgery

REPORT ON 48 CASES OF TENDON TRANSPLANTATION OF THE FOOT. PHYSIOLOGICAL METHOD.

BY A. STEINDLER, M.D., F.A.C.S., IOWA CITY, IOWA.

Some time ago the author, in a paper in this Journal, on "Nutrition and Vitality of the Tendon in Tendon Transplantation," pointed to the advisability of preserving the physiological integrity of the tendon in surgical manipulation. This postulate for surgical procedure consists first in preserving or reconstructing the normal gliding apparatus of the tendon as advocated by Biesalski and Mayer.

To this was added the point of preserving the mesotenon of certain tendons for the sake of the nutrition of the tendon or, in other words, the avoidance of stripping procedures.

As to the necessity of reconstructing the gliding apparatus there exists now no diversity of opinion. As to the necessity of preserving the mesotenon of certain tendons the views may differ. It may be that some tendons will stand to a certain degree, to be stripped of mesotendoneal attachments. However, I have had occasion to observe, at secondary operation, evidence of degeneration following preceding stripping procedures. The strict observance of these physiological points may be considered by some to be too rigid a restriction in the application of tendon transference. But I believe in order to reclaim this method from the great discredit into which it has fallen, it was necessary to relegate it to its proper place and to eliminate a number of extensive tendon transplantations in many cases in which arthrodesis would be indicated instead of tendon transplantation.

Consequently, so far as the foot and ankle are concerned, the question resolves itself into three or four problems, owing to the fact that only a few tendons may be used for interexchange without violating the principles laid down in the above remarks.

The problems are as follows:

1. In paralysis of the tibialis anticus alone or along with slightly paralyzed extensors of the foot, the question of its substitution by the extensor of the big toe is to be considered. The fact that the latter muscle is so much weaker than the tibialis anticus should not absolutely militate against the exchange of these two tendons as long as the tibialis postieus is acting. In this report is included a number of cases of apparently isolated paralysis of the tibialis anticus, some with development of high arch and even contractures of the short flexors of the toes.

The technique of this operation has been described in a former publication.

2. Paralysis of the tibialis postieus. In paralysis of the tibialis postieus, substitution may be made by using the long common flexor of the toes which is located behind the sheath of the tibialis postieus. Both tendons can be embedded into a common sheath.

3. In paralytic pes calcaneus of moderate degree only, with paresis of gastrocnemius muscle, substitution can be made by using the tendon of the peronei. An incision, made midway between the outer edge of the tendo Achillis and posterior edge of the peronei, will give equal access to both sheaths, and side to side attachment of the tendon will be possible without interfering with broad mesotendoneum of the peronei.

4. Leo Mayer has described a technique for substitution of the paralyzed tibialis anticus by the peroneus longus. This latter tendon and muscle is isolated by long incision, liberated high up, inserted into the sheath of the tibialis anticus and fastened to the insertion of the scaphoid. This method was carried out in three cases.

5. In cases of paralysis of both tibialis anticus and tibialis postieus, a double transplantation was used combining the method of group 1 and 2; substitution of the tibialis anticus by the extensor of the big toe, of the tibialis postieus by the flexor of the big toe.

6. In cases of paralysis of either tibialis anticus or tibialis postieus combined with paresis of the gastrocnemius a double transplantation was done, combining method of group 1 or 2 with that of group 3, *i.e.*, substitution of the tibialis anticus by extensor hallucis or the tibialis postieus by the flexor digitorum and of the gastrocnemius by the peronei.

7. Finally, in cases of paralysis of both tibialis anticus and posticus and of the gastrocnemius, a triple transplantation was carried out, combining methods 1, 2, and 3; substitution of the tibialis anticus by the extensor of the big toe, of the tibialis posticus by the flexor of the toes and of the gastrocnemius by the peronei.

The main reason that tendon transplantation has fallen into disrepute is, in my opinion, aside from the disregard of certain physiological requirements, the fact that the indication of this method has been unduly extended to cases in which the existing indication was undoubtedly that of arthrodesis.

I submit in the following a report of 48 cases, in all of which the technique of tendon sheath preservation and preservation of the nutrition has been strictly observed, with the exception of the three cases of Mayer's method in which the peroneus tendon had to be severed from its mesotenon.

The operative results are graded as good, fair or poor. As a good result are regarded those cases in which there was not only distinct action of the implanted tendon in the direction of the paralyzed tendon, but where this action was also maintained during weight bearing and no disturbance of the balance existed.

As fair result are mentioned the cases in which there was only a slight muscle action, but no disturbance of balance on weight bearing.

All cases showing less result than this are classed as poor.

In determining definite results those cases are singled out in which one year or more has passed after operation in which weight bearing is allowed without any supporting contrivance, patient wearing an ordinary shoe.

GROUP 1. SINGLE TRANSPLANTATION. EXT. HALL. UPON TIB. ANT.

No.	NAME, AGE, DURATION	RESIDUAL PARALYTIC CONDITION. MUSCLES PARALYZED	OPERATION	OBSERV.	RESULT
1	H. S., 10 yrs. 6 yrs.	L. paralytic valgus. R. calcaneo-valgus	9-20-17 Ext. hall. to tib. ant. First oper. 9-9-15. Tendon transpl., old method, poor result.	1 yr.	Poor. Active extension but no supination. Paralysis too extensive. Should have had arthrodesis.
2	R. C., 8 yrs. 4 yrs.	L. paralytic valgus. R. total paral. Isolated paral. of tib. ant.	2-16-17 L. foot ext. hall. to tib. ant.	1 yr. 2 mos.	Good. Active supination. No. valgity on weight bearing. Wears ordinary shoe.
3	R. T., 16 yrs. 11 yrs.	R. paralytic club. L. paralytic valgus. L. isolated paral. tib. ant.	8-15-18 Ext. hall. to tib. ant. Lengthening tendo Ach.	6 mos.	Good. Good active supination. In cast.
4	W. M., 23 yrs. 14 yrs.	R. paralytic valgus. Paral. tib. ant. and post.	1-2-17 R. foot. ext. hall. to tib. ant. Lengthening tendo Ach.	2 yrs.	Good. Distinct supination. Wears ordinary shoe.
5	C. S., 10 yrs. 6 yrs.	L. paralytic valgus. Isolated paral. tib. ant.	2-13-17 Ext. hall to tib. ant. Tenotomy tendo Ach.	1 yr. 4 mos.	Good. Very good active supination. No valgus tendency when walking. Wears ordinary shoe.
6	R. S., 7 yrs. 7 yrs.	L. paralytic equino-valgus. Isolated paral. tib. ant.	4-5-17 L. foot ext. hall. to tib. ant. Lengthening tendo Ach.	1 yr. 3 mos.	Good. Very good active supination. No valgus tendency when walking. Wears ordinary shoe.
7	N. T., 12 yrs. 7 yrs.	L. paralytic equino-valgus. Isolated paral. tib. ant.	4-18-17 L. foot. Ext. hall. to tib. ant. Lengthening of tendo Ach.	1 yr. 1 mo.	Good. Active supination. No valgity when walking. Wears ordinary shoe.

8	D. C., 9 yrs. 8 yrs.	R. paralytic valgus. L. paralytic calcaneo-valgus L.foot paral. tib ant. and post.	5-22-17 R. foot. Ext. hall. to tib. ant. Lengthening of tendo Ach.	1 yr. 6 mos.	Good. Good active supination. No valgus tendency. Wears ordinary shoe.
9	R. M., 8 yrs. 3 yrs.	R. paralytic valgus. Paral. of tib. ant. and post.	6-12-17 R. foot. Ext. hall. to tib. ant.	1 yr. 9 mos.	Good. Good active supination. No valgity. Wears ordinary shoe.
10	C. L., 11 yrs. 6 yrs.	R. paralytic equino-valgus and cavus. Paral. tib ant. and post.	5-22-17 R. foot. Ext. hall. to tib. ant. Stripping os calcis.		Good. Active supination. No valgity. Did not report again.
11	H. H., 8 yrs. 6 yrs.	R. foot equino valgus and cavus. Isolated paral. tib. ant. with high arch.	5-25-17 Ext. hall. to tib. ant. Tenotomy tendo Ach.		Did not report back.
12	E. S., 11 yrs. 7 yrs.	R. foot paral. equino-valgus. L. paral. calcaneo-valgus. Isolated paral. tib. ant.	6-27-18 R. foot. Ext. hall. to tib. ant. Tenopl. tendo Ach. 7-9-17 L. Whitman.	7 mos.	Good. Active supination. No valgity. Wears ordinary shoe.
13	R. C., 9 yrs. 1 yr. 1 mo.	R. foot paral. valgus. Paral. tib. ant. and post.	8-6-18 Ext. hall. to tib. ant. Tenotomy tendo Ach.	6 mos.	Good. Active supination. No valgity. In cast.
14	R. G., 8 yrs. 6 yrs.	R. foot paral. Paral. tib. ant. gastrocn.	9-12-17 R. foot. Ext. hall. to tib. ant. Tenotomy tendo Ach.	1 yr. 4 mos.	Good. Active supination. No valgity. Wears brace.

No.	Name, Age. Duration	Residual Paralytic Condition Muscles Paralyzed	Operation	Observ.	Result
15	K. G., 11 yrs. 8 yrs.	R. foot paral. valgus. L. calcaneo-valgus. Isolated paral. tib. ant.	12-6-18 R. foot. Ext. hall. to tib. ant. Tenotomy tendo Ach. 10-28-17 L. foot. Whitman.	1 mo. 1 yr. 1 mo.	Still in cast. Good.
16	A. H., 14 yrs. 7 yrs.	L. foot paral. valgus. Isolated paral. tib. ant.	3-28-18 L. foot. Ext. hall. to tib. ant. Tenotomy tendo Ach.	6 mos.	Good. Active supination. No valgity. In cast.
17	M. S., 12 yrs. 7 yrs.	L. paralytic equino-valgus. Partial paral. tib. ant..	5-17-18 Ext. hall. to tib. ant. Tenotomy tendo Ach.	8 mos.	Good. Active supination. No valgity. Wears ordinary shoe.
18	M. S., 12 yrs. 9 yrs.	R. paralytic equino-valgus. Isolated paral. tib. ant.	5-4-18 Ext. hall. to tib. ant. Tenotomy tendo Ach.	8½ mos.	Good. Active supination. No valgity. Wears brace.
19	L. C., 8 yrs. 2½ yrs.	R. paralytic valgus. Isolated paral. tib. ant.	5-23-18 R. foot. Ext. hall. to tib. ant.	6 mos.	Good. Active supination. No valgity. Still in cast.
20	C. D., 9 yrs. 7 yrs.	R. paralytic equino-valgus. Isolated paral. tib. ant.	6-22-18 R. foot. Ext. hall. upon tib. ant.	6 mos.	Good. Active supination. No valgity. Wears brace.
21	D. F., 16 yrs. 8 yrs.	R. paralytic valgus.	7-2-18 Ext. hall. to tib. ant.	6 mos.	Good. Active supination. No valgity. Still in cast.
22	L. R., 10 yrs. 7 yrs.	R. paralytic valgus. Paral. tib ant. and post.	9-12-17 Ext. hall. to tib. ant.	1 yr. 4 mos.	Very good. Active supination. No valgity. Wears ordinary shoe.

GROUP 2. SINGLE TRANSPLANTATION. FL. DIG. TO TIB. POST.

No.	DURATION NAME, AGE,	RESIDUAL PARALYTIC CONDITION. MUSCLES PARALYZED	OPERATION	OBSERV.	RESULT
1	N. S., 13 yrs. 12 yrs.	R. paralytic valgus. L. paralytic contr. Paral. tib ant. and post.	1-8-18 R. fl. dig. to tib. post.	10 mos.	Poor. Insufficient substitution. In cast.
2	D. D., 6 yrs. 4 yrs.	R. paralytic valgus. Paral. tib. post.	12-4-18 R. foot. Fl. dig. to tib. post.	1 yr. 2 mos.	Good. Active supination of tib. post. No valgity. Wears ordinary shoe.

GROUP 3. SINGLE TRANSPLANTATION. PERONEI TO TENDO-ACHILLIS.

No.	DURATION NAME, AGE,	RESIDUAL PARALYTIC CONDITION. MUSCLES PARALYZED	OPERATION	OBSERV.	RESULT
1	K. H., 6 yrs. 6 yrs.	R. paralytic calcaneus. Paralyzed gastrocn.	5-29-17 R. foot. Peronei to tendo Ach. Tenotomy of tendo Ach.	1 yr. 3 mos.	Good. Good action of tendo Achillis. Wears ordinary shoe.
2	J. Q., 4 yrs. 3 yrs.	R. paralytic calcaneus.	6-16-18 Peronei to tendo Ach.	7 mos.	Good action. Tendo Achillis. In cast.
3	R. P., 4 yrs. 4 yrs.	Spastic equinus-valgi, congenital.	1-16-19 Both feet. Peronei to tendo Ach.		Too recent. In cast.
4	A. S., 7 yrs.	R. paralytic calcaneus.	3-8-17 R. foot. Peronei to tendo Ach.	1 yr. 8 mos.	Good. Good action of tendo Achillis. Wears ordinary shoe.
5	W. H., 10 yrs. 10 yrs.	Spastic equino-valgi.	10-18-17 L. foot. Peronei to tendo Ach.	1 yr.	Good. No calcaneus tendency of foot. In braces

GROUP 4. SINGLE TRANSPLANTATION. PERONEUS LONGUS TO TIB. ANT. MAYER'S METHOD.

No.	DURATION NAME, AGE.	RESIDUAL PARALYTIC CONDITION. MUSCLES PARALYZED	OPERATION	OBSERV.	RESULT
1	M. H., 6 yrs. 6 yrs.	R. paralytic equino-valgus. Paralysis tib. ant. and post.	8-5-18 R. foot. Peroneus long. to tib. ant.	2 mos.	Good. Too recent. Still in cast.
2	A. M., 12 yrs. 6 yrs.	L. paralytic calcaneo-valgus Paral. tib. ant and post. Partial paral. gastrocn.	10-3-18 L. foot. Peroneus long. to tib. ant. Peroneus brevis to tendo Ach.	3 mos.	Good. Active supination. Active plantar flexion.
3	B. R., 14 yrs. 9 yrs.	R. paralytic valgus. Paral. shoulder, elbow and hand. Paral. tib. ant. and post.	8-13-18 R. foot. Peroneus long. to tib. ant.	5 mos.	Good. Active supination.

GROUP 5. DOUBLE TRANSPLANTATION. EXT. HALL. TO TIB. ANT.; FLEXOR DIGIT. TO TIB. POST.

No.	DURATION NAME, AGE.	RESIDUAL PARALYTIC CONDITION. MUSCLES PARALYZED	OPERATION	OBSERV.	RESULT
1	M. O., 10 yrs. 8 yrs.	R. paralytic valgus. Paral. tib. ant. and post.	5-15-17 Ext. hall. to tib. ant. 2-21-18 Fl. dig. to tib. post.	1 yr. 8 mos. 11 mos.	Good. Active supination. No valgity. Result improved by second transplantation. Wears ordinary shoe.
2	E. H., 5 yrs. 2 yrs.	R. paralytic valgus. Paral. tib. ant. and post.	8-15-18 Ext. hall. to tib. ant. Fl. dig. to tib. post.	6 mos.	Fair. Action of tib. ant. good. Action of tib. post. poor. In cast.
3	L. R., 10 yrs. 7 yrs.	R. paralytic valgus (moderate). L. paralytic valgus (pronounced).	8-22-18 Fl. dig. to tib. post. L.	5 mos.	Good. Still in cast.
4	B. H., 11 yrs. 2 yrs.	L. paralytic valgus. Paral. tib. ant. and post.	5-7-18 L. foot. Ext. hall. to tib. post.	8 mos.	Good. Active supination. No valgity. Wears brace.

5	L. O., 10 yrs. 7½ yrs.	R. paralytic calcaneo-valgus. L. paralytic valgus.	2-16-18 L. foot. Ext. hall. to tib. ant. Fl. dig. to tib. post.	1 yr.	Poor. Active supination slight. Valgity on weight bearing. Should have had arthrodesis.
6	V. S., 9 yrs. 5 yrs.	R. paralytic valgus. L. paralytic valgus.	5-21-17 Transpl. r. foot. 7-5-18 Ext. hall. to tib. ant. Fl. dig. to tib. post.	1½ yrs.	Poor. Active supination but valgity on weight bearing. In braces. Whitman operation should have been performed.
7	G. S., 16 yrs. 14 yrs.	R. paralytic valgus. L. paralytic equinus.	9-9-17 Transpl. r. foot. 8-1-18 Ext. hall. to tib. ant. Fl. dig. to tib. post.	1 yr. 4 mos.	Poor. Action of tib. ant. but no active supination. Valgity on weight bearing. Indication arthrodesis.

GROUP 6. DOUBLE TRANSPLANTATION. PERONEI TO TENDO-ACHILLIS; EXT. HALL. TO TIB. ANT. OR FL. DIG. TO TIB. POST.

No.	NAME, AGE, DURATION	MUSCLES PARALYZED RESIDUAL PARALYTIC CONDITION.	OPERATION	OBSERV.	RESULT
1	P. M., 8 yrs. 6½ yrs.	R. paralytic calcaneo-valgus. Paral. tib. ant. and post.	5-2-17 Right. foot tendon transpl. 8-2-17 Peronei to tendo Ach. Ext. hall. to tib. ant.	1 yr. 5 mos.	Good. Good active supination. No valgity. Wears ordinary shoe.
2	W. H., 8 yrs. 6½ yrs.	R. paralytic calcaneo-valgus. Paral. of tib. ant., tib. post., tendo-Achillis.	10-25-17 Ext. hall. to tib. ant. Peronei to tendo Ach.	1 yr. 3 mos.	Good. In cast.
3	G. L., 12 yrs. 7 yrs.	L. paralytic calcaneo-valgus. Paral. of tib. ant., tib. post., tendo-Achillis.	6-28-17 L. foot. Ext. hall. to tib. ant. Peronei to tendo Ach.	1 yr. 6 mos.	Poor. No supination.

No.	Name, Age. Duration	Residual Paralytic Condition. Muscles Paralyzed	Operation	Observ	Result
4	W. A., 8 yrs. 6 yrs.	L. paralytic calcaneo-valgus. Paral. tib. ant., tib. post., gastrocn.	5-29-17 6-30-17 Ext. hall. to tib. ant. Peronei to tendo Ach.	1 yr. 7 mos.	Fair. No valgity. Slight power of supination. Still in cast.
5	R. D., 6 yrs. 1½ yrs.	R. paralytic calcaneo-valgus. Paral. tib. ant., tib. post., gastrocn.	7-5-17 Ext. hall. to tib. ant. Peronei to tendo Ach.	4 mos.	Good. Did not report again.
6	W. S., 11 yrs. 9 yrs.	L. paralytic calcaneo-valgus. Paral. tib. post., gastrocn.	11-13-17 Fl. dig. to tib. post. Peronei to tendo Ach.	4 mos.	Good. Did not report later.

Group 7. Triple Transplantation. Ext. Hall. to Tib. Ant.; Fl. Dig. to Tib. Post.; Peronei to Tendo-Achillis.

No.	Name, Age. Duration	Residual Paralytic Condition. Muscles Paralyzed	Operation	Observ.	Result
1	D. C., 11 yrs. 7½ yrs.	R. calcaneo-valgus. Paral. tib. ant., tib. post., gastrocn.	6-6-17 Ext. hall. to tib. ant. 8-18-18 Fl. dig. to tib. post. Peronei to tendo Ach.	1 yr. 5 mos.	Good. Wears brace.
2	S. D., 7 yrs. 5 yrs.	L. calcaneo-valgus. Paral. tib. ant., tib. post., gastrocn.	4-2-18 Ext. hall. to tib. ant. Fl. dig. to tib. post. Peronei to tendo Ach.	9 mos.	Good. In cast.
3	L. G., 11 yrs. 8 yrs.	L. calcaneo-valgus. Paral. tib. ant., tib. post., gastrocn.	10-20-17 5-23-18 Ext. hall. to tib. ant. Fl. dig. to tib. post. Peronei to tendo Ach.	1 yr. 8 mos.	Fair. In cast.

	Total	Total Results			Not Determined
		Good	Fair	Poor	
Group 1	22	20	0	1	1
Group 2	2	1	0	1	0
Group 3	5	4	0	0	1
Group 4	3	2	0	0	1
Group 5	7	3	1	3	0
Group 6	6	4	1	1	0
Group 7	3	2	1	0	0
Total	48	36	3	6	3

Of this group of 48 cases, 36 showed good result, or 75%. The rest are divided into fair, poor, and undetermined on account of too recent operation.

Result in Cases Observed One Year or More.

	Total	Result			
		Good		Fair	Poor
		Wearing Shoe	Wearing Cast or Brace		
Group 1	10	8	1	0	1
Group 2	1	1	0	0	0
Group 3	3	2	1	0	0
Group 4	0	0	0	0	0
Group 5	4	1	0	0	3
Group 6	4	1	1	1	1
Group 7	2	0	1	1	0
Total	24	13	4	2	5

By eliminating all cases in which less than one year had elapsed bebetween operation and time of writing, there remain 24 cases which have been observed one year after operation. Of these, 17 cases, or 70%, showed good result. By again eliminating all cases which are still in some kind of supporting contrivanee, as cast or brace, we have at present 13 cases, or 57%, which have definitely shown good operative results. Of the four remaining in cast it is to be expected that their present good result will be added to this number, making a definite percentage of good result, reaching the neighborhood of 70% for all cases.

IMPAIRMENT OF FUNCTION OF THE HAND DUE TO WAR INJURIES.

BY CARLETON R. METCALF, M.D., CONCORD, N. H.,
Major, M. C., U. S. A., France.

SUMMARY OF CONTENTS.

I. Recent Wounds of the Hand.
   a. Joints not involved.
      1. Need for active movement.
   b. Joints involved.
      1. Proper splinting. Position of choice if anchylosis is anticipated.

II. Old Wounds of the Hand.
   a. Joints not involved.
      1. Gradual mobilization. Tendon transplantation.
      2. Gradual mobilization in Volkmann's paralysis.
   b. Joints involved.
      1. Futility of manipulation, of gradual mobilization, of resection, of dissection of tendons, of plastic operations on tendon sheaths.
      2. Possibility of anchylosis in position of choice.
      3. Occasional need for amputation.
      4. Time interval for reconstructive operations.

III. Peripheral Nerve Lesions.
   a. Diagnosis of median, ulnar and musculo-spiral lesions.
      1. Motor changes. Deformity. Atrophy. Vasomotor changes. Sensory disturbances.
   b. Treatment of nerve lesions.
      1. Nerve suture.
      2. Preparation of muscles and joints for returning function. Splinting for paralyzed muscles.
      3. Tendon transplantations.

IV. Functional Paralysis.

V. Summary of Paper.

Our subject includes impairment due to lesions of the peripheral nerves in the arm and forearm and that due to so-called functional causes, as well as impairment which follows local injuries of the hand itself, with destruction of bones, joints and tendons. I shall give little thought to wound healing, but consider, rather, diagnosis and proper mechanical treatment: early treatment which prevents deformity, and after-treatment which leads to satisfactory function. In many war injuries, including those involving the hand, skillful early treat-

ment minimizes,—aborts even,—subsequent deformities which impair function. My cases number about one hundred.

I. RECENT WOUNDS OF THE HAND.

a. Joints Not Involved. If a wound is recent, but does not involve a joint, if there is no reason to expect permanent joint stiffness, if there is no joint inflammation,—then I encourage active movement from the start, in elbow, wrist, and hand, and daily move all these joints, once at least, through their complete range of motion. Thus one prevents stiffness and avoids the necessity of manipulating later under an anaesthetic. In that it maintains nutrition, a useful adjunct is massage. In uninjured areas it is indicated, of course, at any time. During convalescence, in an injured area, deep massage promotes circulation in newly formed masses of cicatricial tissue. In this connection, active manual work in a curative workshop should not be forgotten.

b. Joints Involved. If one excludes nerve and so-called functional lesions, impairment of function in the hand is due usually to stiffened, ill-positioned joints. If a joint itself has recently been wounded, if neighboring tendons or other tissues in its vicinity are destroyed, as an aftermath of the dense scar that is sure to form, one may hope for nothing better than a stiff joint; and in this event it is essential that the joint become fixed in its position of greatest utility.

This axiom suggests at once the importance of proper splinting. Not every hand injury requires the application of a splint. But if a splint be necessary, it is obvious that its use should be continued until danger of deformity has been eliminated; it is obvious that it should not be applied too tightly, for this ill-omened procedure may lead to ischaemic paralysis (Fig. 1). These two rules are usually observed; it is not un-

FIG. 1.—Ischaemic paralysis from bad splinting. No nerve lesion.

common, however, for splints to be applied in an improper position.

To use the hand with facility, a patient must be able: 1, To supinate the palm at least half-way; 2, to dorsiflex the wrist-joint; 3, to bend the metacarpo-phalangeal joints nearly, if not quite, to a right angle.

If, then, one expects, as an end result, permanent loss of supination and of pronation, let the forearm be fixed,—let the hand be in a position,—approximately midway between these two, erring slightly on the side of supination. Secondly, let all injuries in the neighborhood of the wrist-joint be fixed with the wrist dorsi-flexed. A straight splint or no splint at all permits palmar flexion; and with palmar flexion one gets improper balance between the strong flexors of the fingers and the relatively weak extensors, resulting in incomplete closure of the fingers and a powerless hand-grasp. A splint which dorsiflexes the wrist should lie on the ventral, rather than on the dorsal, aspect of the forearm. For the reason that the Jones short cock-up splint prevents flexion at the metacarpo-phalangeal joints, it is an imperfect splint. A proper cock-up has so little bearing surface in the palm of the hand that it permits flexion at these joints and does not modify the contour of the palmar arch; it extends well up the forearm. Very satisfactory cock-ups may be made from plaster of Paris (Fig. 2). Finally, if one expects permanent anchylosis of a metacarpo-phalangeal joint, let such a joint be fixed in semi-flexion.

FIG. 2.—Short cock-up splint. Plaster of Paris. Metacarpo-phalangeal joints have free movement.

These positions of choice are not demanded immediately after injury. Indeed, for the first few days, the injured region should be placed in a position of rest. Rough handling should be scrupulously avoided. But, shortly, account must be taken of the position necessary for a good functional result. Deformity accruing from contracting scar tissue, be it deep or superficial, must be modified,—must be counteracted,—by resistance, either continuous or intermittent (Fig 3).

FIG. 3.—Superficial wound, flexor surface of wrist. Contracture. Improper splinting.

II. OLD WOUNDS OF THE HAND.

a. Joints Not Involved. We have considered so far patients with recent wounds,—first, those with wounds which do not involve a joint, and secondly, those with wounds involving a joint. Consider, now, a large group of patients with old wounds which do not involve a joint, but in whom the joints of the hand have been allowed to become stiff in an improper position: joints which still retain much of their former integrity and which are controlled by muscles and tendons that still functionate. Their customary method of attempting to mobilize such joints by vigorous manipulation under an anaesthetic is futile, unless a patient can be induced to continue active movement immediately after manipulation. Too often a patient is unwilling to do this because of pain, for, by manipulation, a quiescent joint has, perhaps, been converted into an acutely inflamed one. More, then, may ordinarily be accomplished by gradual mobilization. In the case of the hand it is my custom to observe the following procedure:

1. If the fingers are fixed in flexion. Place the wrist in a position of palmar flexion and maintain this position by counter-pressure on

the dorsum of hand. Procure, first, extension of the interphalangeal joints; next, of the metacarpo-phalangeal joints; and, finally, dorsiflexion of the wrist-joint.

2. If the fingers are fixed in extension. Place the wrist in dorsiflexion and maintain this position by counterpressure in the palm of the hand. Procure, first, flexion of the metacarpo-phalangeal joints; next, of the interphalangeal joints.

Realization is often a very difficult matter, but if freedom of motion is to be had at all, it is had fairly quickly. There are sundry devices for procuring gradual mobilization. The violin splint, first described, I believe, by Osgood, is serviceable for either type of case, but has to be adjusted carefully and frequently. Another good one, particularly for cases of the second group, is the simple plaster splint devised by Langworthy. To make this splint, for a case of the second group, form a plaster-of-Paris gutter over the extensor surfaces of forearm, hand and fingers. On the upper surface of the gutter place a layer of stout cloth. And on the upper surface of the cloth a second layer of plaster-of-Paris bandages. Bind the edge. Dry thoroughly. Score each plaster layer cross-wise at a level of the several joints, leaving untouched the layer of cloth, which serves, in each instance, as a hinge. Day by day, increasing flexion may be secured in the metacarpo-phalangeal and in the interphalangeal joints, by flexing the hinged distal portion of the splint. Flexion thus gained is maintained by adhesive strips running over the end of the splint. The proximal end of the splint is anchored to the forearm by a wide adhesive plaster band.

The idea is more important than a particular device; whichever is used, one must bear in mind, primarily, the three cardinal requisites for good hand motion,—uamely, ability to semi-supinate, to dorsiflex the wrist, and to flex the metacarpo-phalangeal joints; and, in the second place, the need of removing apparatus daily, in order to move each joint through its full permitted range of motion.

If a wound is not in proximity to a joint, but has destroyed a tendon, one may sometimes have recourse to tendon transplantation. Suppose, for example, a wound over the third metacarpal bone which has invalidated the extensor to this finger,—and, ordinarily, the extensors rather than the flexors are invalidated. In such an exigency one may transplant the proximal end of the tendon of the extensor indicis into the distal end of the extensor of the third digit. Such a transplantation is obvious, and, although the field is limited, other similar opportunities now and again arise. But it should be borne constantly in mind that tissues in the region of transplantation must be fresh. It

is impossible to transplant successfully in an area already impaired by scar.

Gradual mobilization is pertinent in instances of Volkmann's contracture which occasionally follow war injuries, due either to tight bandaging or to pressure within the arm. In this, the contracture is caused by partial coagulation of the proteids of the muscles which terminates in a fibrous myositis. To cure the condition, operative procedures are ineffective. Far better results are obtained by fixing in proper position, successively, the several groups of joints.

1. With the wrist in flexion, the fingers may be straightened and splinted, with finger-splints or plaster finger-cots.

2. A few days (three or four) later, with the wrist still in flexion, the metacarpo-phalangeal joints are stretched, and the splinted fingers and palm are placed on a flat splint.

3. After another lapse of a few days, the wrist may gradually be dorsiflexed.

The degree of recovery depends, of course, on the amount of muscle destruction and the age of the patient. In some instances in children recovery has been complete.

b. Joints involved. Let us take up now a fourth group of hand lesions: joints that are stiff in an improper position, joints which retain little or none of their former integrity, bordered by scar tissue and partly destroyed tendons. In the hand, it is obvious that a missile which destroys a joint must usually destroy adjacent soft tissues, including tendons. It is true, also, that in war injuries one sees, oftener than in civil practice, a synovitis spreading along tendon sheaths from the injured area. One is tempted, at first, to putter with lesions of this sort; to try to restore function by:

1. Passive manipulation under an anaesthetic, designed to loosen joints and to free tendons.

2. Gradual stretching of the kind advocated in a preceding paragraph.

3. Resection of a joint, in the hope of forming a mobile articulation.

4. Dissection of tendons from scar tissue, with suture of the tendon ends, if they be cut.

5. Formation of tendon sheaths from fascia lata, Cargile membrane or other extraneous tissue.

These procedures have a very, very limited field of usefulness. A joint which has been invaded by a missile, which has been allowed to

drain and has become stiff, will never become freely movable under manipulation; nor will this manoeuvre ever free, permanently, tendon buried in scar tissue. The manufacture of new joints under the given premises, I regard as an almost hopeless task. No attempt to repair or to free tendons in an area of scar tissue, has, to my knowledge, been successful. And to provide new tendon sheaths from a foreign tissue, in the expectation of getting a smooth runway, is to court failure. I have never utilized fat tissue for this purpose and it is fair to say that recent reports would lead one to believe that a properly functioning tendon sheath may be made from fat tissue.

Now for constructive facts. By manipulation or by open operation the wrist-joint may be placed in a cock-up position and permitted to anchylose, for we must never forget that this is the position of choice. For wounded, stiffened joints of the digits or of the metacarpo-phalangeal range I know of no satisfactory treatment. We must usually admit defeat by resorting to amputation. A stiff, extended finger is a nuisance. Not only is it in the way, but, if it be one of the last three digits, one finds that the lateral vincula,—the accessory slips,—of the extensor communis digitorum make an admirable check-rein on flexion of the remaining intact digits.

If adjoining fingers are intact, it is not always a wise policy to save as much of a finger as possible, even in cases where the stump is freely movable. A movable stump is useless unless it has gripping power; a third of a finger is often worse than none at all. Certainly if the stump is immobile, it is well to amputate just behind the metacarpal head. If two or more fingers are to be amputated, the metacarpal bones must be removed more liberally, in order to bring the remaining digits into closer approximation. The thumb is the most valuable digit, the index finger next. With these two alone, in good working order, a patient may accomplish much; and the loss of one or two fingers, of itself, incapacitates a hand little, provided that the thumb may be brought into apposition with the other digits.

To these somewhat radical suggestions one must make this exception. If a hand is badly shattered, but still retains mobility in one or another joint, it is sometimes advisable to save as much as possible from the wreckage,—to procure, perhaps, a mobile thumb and an index finger stiffened in semiflexion. Otherwise, our only alternative may well be amputation of the hand. And while this war has brought forth a few satisfactory and inexpensive substitutes for a man's hand, they are designed particularly for the laboring man. I know of only one that is aesthetic and delicate and that one is expensive (Fig. 4).

FIG. 4.—Extensive involvement of extensor tendons. Amputation of the two middle fingers indicated.

We all know that many war wounds may be successfully closed by delayed primary or by secondary suture,—yes, even by primary suture, —that, in clean cases, tendons may be sutured initially, that nerves may be so repaired. If, to the contrary, a wound is drained, it is essential to delay reconstructive operations for several months, for fear of "latent sepsis." With injuries to soft tissues alone, three months should elapse after a wound has healed; with injuries to bone, at least six months. I have seen "latent sepsis" burst into a most active sepsis eight months after the healing of a compound fracture of the radius. And at the time of a reconstructive operation fifteen hundred units of antitetanic serum are to be given. At this operation, too, one must be careful to dissect out old scar tissue, with its imbedded nerve filaments. Painful scars are all too common. In amputating, surgeons often forget that nerves should be pulled on a stretch and cut short.

III. IMPAIRMENT DUE TO PERIPHERAL NERVE LESIONS.

Here we have a very different type of case: that in which there is impairment due to injury of the peripheral nerves supplying the hand. The peripheral nerves with which we are concerned are three: the median, ulnar, and musculo-spiral.

a. Diagnosis of Median, Ulnar, and Musculo-spiral Lesions. The diagnosis of a particular lesion, the determination of prognosis and of treatment,—these are usually dependent on the observation of:

1. Motor response to faradic (and galvanic) current in specific muscles.
2. Active muscular response on the part of the patient.

3. Deformity and atrophy.
4. Vasomotor changes.
5. Sensory disturbances in the areas of distribution.

We are familiar with the fact that, in muscle tissue bereft of its nerve supply, reaction to degeneration begins in about a week or ten days after the nerve supply is cut off. For one experienced in electrotherapeutics it is therefore a simple matter to determine the scope of a nerve lesion affecting the hand, by stimulating the determining muscles over their motor points.

Oftentimes a correct diagnosis may be made without this refined procedure. The median nerve, for example, either directly or through its anterior interosseous branch, supplies all the muscles on the flexor surface of the forearm, except the flexor carpi ulnaris and the inner half of the flexor profundus digitorum. In the hand, the median supplies four and one-half muscles: the two outer lumbricals, the opponens pollicis, the abductor pollicis, and half of the flexor brevis pollicis. A patient, then, who has a complete median lesion cannot flex the terminal phalanx of his thumb (flexor longus pollicis); furthermore, with a complete lesion, on flexion of the wrist the hand is drawn to the ulnar side, because of paralysis of the flexor carpi radialis (Fig. 5). The forearm cannot be pronated beyond the midposition. There

FIG. 5.—Bullet wound, lower third right arm, on Sept. 8, 1916. Median nerve cut just below pronator radii teres. Sutured on April 23, 1917. Intense cyanosis. Note bending to ulnar side from overaction of flexor carpi ulnaris.

is atrophy of the ventral surface of the forearm and of the thenar eminence, without atrophy of the hypothenar. When at rest, the hand may show little or no deformity. If a median lesion is in the lower half of the forearm, a noticeable sign is inability to adduct the thumb and to rotate it inward (opponens pollicis).

The ulnar nerve, in the forearm, supplies the flexor carpi ulnaris

and the inner half of the flexor profundus digitorum. In addition, it supplies all the muscles of the hand except the four and one-half muscles just enumerated in the median group. A patient with ulnar paralysis cannot abduct and adduct his little finger. The hypothenar eminence and palm, as well as thenar eminence are much wasted. Owing to paralysis of the interossei, whose action is to flex the metacarpo-phalangeal joints and to extend the interphalangeal joints, the metacarpo-phalangeal joints become extended and the interphalangeal joints flexed. This deformity is most marked in the last two fingers, for there we have concomitant paralysis of the inner lumbricals (Fig. 6).

FIG. 6.—Shrapnel wound, upper third of arm, involving ulnar nerve. Characteristic ulnar deformity nine months after injury. Has had no treatment.

The musculo-spiral nerve, in the forearm, supplies the supinator longus and the extensor carpi radialis longior. Through its posterior interosseous branch it supplies all other extensor muscles of the wrist and hand and the supinator brevis. The radial nerve is purely sensory. A patient who has a complete lesion of the musculo-spiral nerve cannot extend his wrist; a patient whose lesion is confined to the posterior interosseous branch cannot extend his fingers at the metacarpo-phalangeal joints.

With each nerve, sensory disturbance corresponds, of course, with the cutaneous distribution. Protopathic loss (*i.e.*, loss to pin-prick) is usually less extensive than epicritic loss (*i.e.*, loss to touch of absorbent cotton). Sensation to deep pressure and to joint movement may persist when the first two are non-existent. In the case of the median, total anaesthesia is rare. Usually one finds blunted sensation. Not infrequently this blunted cutaneous area is hypersensitive to pressure. Severe, spontaneous pains are characteristic; they are aggravated by extreme degrees of temperature, by pressure, or by unexpected jarring. These pains may irritate a patient more or less con-

stantly for weeks or months, and for them I know no adequate means of relief. Not infrequently, too, the affected sensory area is cyanotic and perspires freely. All these features are characteristic of the median; in ulnar and musculo-spiral division they are not so marked.

Sometimes, when a nerve is not divided but is surrounded by scar tissue, it is irritated and one sees over-activity rather than paralysis of the controlled muscles. A tightly clenched hand, for example, suggests median irritation (Fig. 7). In such instances exploration is indicated.

FIG. 7.—Bullet wound, inner surface of right arm, July 23, 1916. Operation on April 22, 1917. Median nerve buried in scar tissue but intact.

In actual practice a diagnosis is ordinarily made by the following routine:

1. Observe regions of atrophy, cyanosis, or of undue perspiration.
2. Observe deformities.
3. Request a patient to make simple movements: to pronate the forearm, flex the terminal phalanx of the thumb and oppose the thumb to the palm (median); to abduct and adduct the little finger (ulnar); to extend the wrist and to extend the fingers at the metacarpo-phalangeal joints (musculo-spiral). I have simplified these tests as much as possible; a more comprehensive series of tests can, of course, be readily worked out.
4. Determine loss of sensation (*a*) with a pin and (*b*) with a fluffy bit of absorbent cotton.
5. Verify findings by the responses of the several muscles to faradic (or galvanic) stimuli, applied to motor points on the muscles. I have come to rely more and more on these electrical findings. Twice I have operated against the advice of my colleague of the electro-therapeutic department, and on both occasions he has been right. I was dealing presumably with a contused nerve on each occasion,—with extravasation of blood into a nerve sheath,—and not with actual section of a nerve.

b. Treatment of Nerve Lesions. If, on the other hand, a nerve is wholly or partly divided or is embedded in scar, operation is advisable. So handicapped, a nerve may make a heroic effort but it cannot rejuvenate itself. From this rule we may except, as we shall presently see, an occasional ulnar or median lesion; we may except the case of a nerve troubled so slightly by scar tissue that the resulting symptoms are infinitesimal. Otherwise the rule is absolute. At operation, scar tissue must be eradicated, even to the extent of dissecting free individual nerve fibrils; it serves no useful purpose merely to score a few longitudinal slits in a nerve sheath. For complete division, unless too lengthy a section of nerve has been destroyed, and for partial division, as well, one ordinarily resorts to nerve suture. Remember that the musculo-spiral almost invariably gives good results, the ulnar and median rarely.

Nerves may be sutured with fine catgut, with silk or with linen; most operators prefer catgut. The joined surfaces may be dropped into place without covering or may be surrounded by a thin slice of adjoining muscle tissue; no foreign membrane should be introduced as a covering. Let me repeat: Do not surround the joined nerve surfaces with Cargile membrane or with any other foreign membrane or fascia. Catgut sutures should penetrate only the nerve sheath. Scarred nerve must be freely excised with a very sharp knife until wholesome fibrils are developed in both proximal and distal portions. Exposed nerves must always be handled with extreme delicacy. A tourniquet may be used (Fig. 8). Up to the present, nerve transplantations have not proved successful; nor have attempts to regrow a nerve through a glass, a celluloid or a collodion tube, in those unfortunate cases where a lengthy section of nerve has been destroyed.

In late cases,—and one is usually confronted with these nerve lesions long after the original injury,—quite as important as suture of the

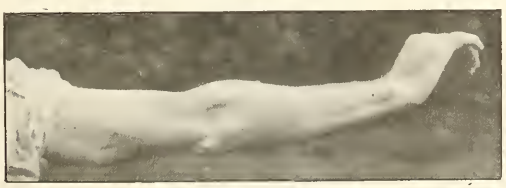


Fig. 8.—Musculo-Spiral Paralysis. Nerve sutured Oct. 12, 1916, upper third right arm. Complete recovery in nine and one-half months.

nerve itself, is the preparation of muscles and joints to receive newly awakened impulses. This will not be a difficult task if splinting has been intelligent from the beginning; unfortunately not a few cases exhibit characteristic contractures. Every effort must be made, then, to restore mobility in joints, to maintain proper muscle tone in stiffened muscles, to free, if need be, muscles from the thongs of scar tissue, to place paralyzed muscles in a position of relaxation. For adjuncts, after operation, we have daily massage and electrical stimulation, which are, perhaps, of service. I say perhaps. As for the form of electricity, faradic shocks should be used if the given muscles will react to faradism; if they will not, the galvanic current must be substituted. A current should be just strong enough to produce contraction, not enough to cause pain. I would lay greater stress, however, on the mechanical correction of existing deformity and the maintenance of paralyzed muscles in a position of absolute rest. This connotes proper splinting.

Every case of paralysis from nerve injury demands a splint and this splint must be used continuously until recovery has taken place or has been despaired of. Let me quote the dictum of Sir Robert Jones:

"When deformity has been corrected the limb should be kept immovable until the ligaments, muscles, and even bone have become of normal length and shape. The continuity of treatment must be maintained or a relapse will result. This point is fundamental, and neglect to observe it spells failure, as the slightest stretching of a muscle on the point of recovery disables it again. All the good work may be thwarted by a single indiscretion. I cannot emphasize this point too strongly. For instance, let us take the case of a drop-wrist which has been placed in a splint designed to dorsiflex the hand at the wrist. The position must be constantly maintained. The hand must not be allowed to flex for a single moment until recovery has occurred. Even while the patient washes, the hand must be held dorsiflexed." (Fig. 9.)

Fig. 9.—Musculo-spiral paralysis. Tendon transplantation in May, 1915. Discharged from hospital *without a splint*. Condition above in January, 1918.

Occasionally one finds, especially with wrist-drop, that this relaxation leads to complete recovery; in other words, the paralysis is apparent, not real. If a surgeon suspects this condition of affairs, he should maintain relaxation indefinitely until he has either been rewarded by a return of normal function or has disproved his suspicion. Three times I have cured complete wrist-drop by immobilization in a dorsi-flexed position for a few weeks.

A suitable splint for paralyzed muscles must accomplish four things:

1. Prevent overstretching of the paralyzed muscles, whether from gravity or from contracture of the opposing muscles.

2. Prevent deformities from contracture of opposing muscles.

3. Allow for treatment,—dressings, massage, even harmless movements,—without removal of the splint.

4. Permit free circulation in the splinted area.

Consider, again, paralysis following musculo-spiral severance. For this paralysis, one would use, preferably, a long cock-up splint which dorsiflexes the wrist and extends both fingers and thumb. A short cock-up splint is contra-indicated because it permits flexion of the fingers. And so for each injury a splint may be evolved which will comply with the above conditions. Stock splints are too often unserviceable; one is frequently better satisfied to mould from plaster an individual splint to meet the requirements of an individual case.

I have implied that nerve suture, on occasion, is impracticable. For this dilemma tendon transplantation at once suggests itself, and the following methods have been found most adequate for each of the nerves that we have considered. Again I quote from Sir Robert Jones:

"*Median Nerve.*

a. The outer tendons of the flexor profundus are inserted into the inner tendons of the same muscle.

b. The tendons of the flexor sublimis are inserted into the tendon of the flexor carpi ulnaris.

c. The extensor carpi radialis longior is attached to the flexor longus pollicis.

Ulnar Nerve.

a. The two inner tendons of the flexor profundus are attached to the two outer.

b. The palmaris longus is inserted into the tendon of the flexor carpi ulnaris.

Musculo-Spiral Nerve.

a. The flexor carpi radialis and the flexor carpi ulnaris are transplanted into the paralyzed extensor of thumb and fingers.

b. The pronator radii teres is affixed to the two radial extensors."

I do not necessarily expect you to remember these details nor shall I describe the technique of the several operations. But I do wish to iterate this salient fact: that in case of irreparable injury to a forearm nerve, good results may be obtained by tendon transplantation (Fig. 10). As for the median, one or two able surgeons no longer

FIG. 10.—Musculo-spiral paralysis. Transplantation of flexor ulnaris and flexor radialis into extensor tendons (without cutting extensors). Can hold wrist easily in this position and further extend 15°.

suture but resort to transplantation at once. Many hands with ulnar lesions have fairly good power, and as neither suture nor transplantation is thoroughly satisfactory, it is an open question whether operation should be advised or deprecated; if function is adequate for the work that a patient must do, I usually deprecate operation. In the case of the musculo-spiral, always suture if possible. Whenever nerve suture is contemplated but, at operation, cannot be carried out, a surgeon must be prepared forthwith to proceed with the appropriate tendon transplantations. The after-care of these cases is, of course, along the lines of that already described for nerve suture.

IV. FUNCTIONAL PARALYSES.

We have seen that some cases of supposed paralysis are not real,—are not due to nerve destruction,—but are due rather to muscle fatigue. We come now to another group that is unreal, the so-called functional cases (Fig. 11). In these no injury to nerve or to muscle can be de-

FIG. 11.—Functional lesion. Bullet wound, right arm. Fingers at first flexed into palm. Now straight but immobile. Electrical reaction normal.

tected; for them operation is of no avail. They yield, if they yield at all, to reëducation and to psychotherapy. One may usually diagnose them readily on the following data:

1. The defect is one of movements of the part as a whole rather than defect in a particular muscle group.

2. Deep reflexes are normal and always present.

3. There is absence of muscle atrophy.

4. One never finds combined, a paralysis of definite muscles and loss of sensation in a corresponding area. Our patient, in other words, exhibits a profound ignorance of nerve distribution.

5. One never finds the exact distribution of a sensory nerve mapped out by anaesthesia. Commonly there is complete anaesthesia below a given level.

6. Finally, the electrical reaction shows no degeneration.

It is essential to exclude the malingerer and to detect the combination of a functional lesion with an organic lesion.

V. SUMMARY OF PAPER.

So far, so good. The points that I would emphasize are these. One must distinguish first between recent wounds and old wounds. With recent wounds, especially of soft tissue, delayed primary or secondary suture,—if possible a partial primary suture,—are the methods of choice. Joints which are not involved, either directly or indirectly, must be kept mobile by daily movement and by massage. Otherwise, while still retaining their integrity, they will quickly become stiff, and careful, gradual manipulation will be required to re-limber them. Joints which are so extensively involved that they are on the road to anchylosis must be placed in those positions which, with anchylosis, will give the most satisfactory functional results.

Too frequently in old cases, one sees deformities and loss of function. In these, where joints are not involved either directly or indirectly, benefit may sometimes be had by gradual mobilization. Joints which are not involved directly, but whose governing tendons are invalidated, are occasionally helped by tendon transplantation, followed by mobilization. If mobilization is impossible it is occasionally necessary to fall back on amputation. Puttering methods of reconstruction are futile.

I have considered, further, a simple method of differential diagnosis among nerve lesions and the differentiation of organic and functional lesions. I have emphasized the importance of preparing an affected region to receive anticipated nerve recovery; by electrical stimulation, by massage, and by proper and continuous splinting. A proper splint must be worked out on an anatomical basis, to the end that it may provide absolute rest for paralyzed muscles and may prevent or correct contracture.

To my mind prevention of contracture is an all-important factor; and it is certain that if hand lesions are treated intelligently from the beginning, if suitable splints are applied, impairment of function may largely be avoided. So that, if this paper be of any value, its worth is derived from the fact that it calls attention to prevention, rather than from suggestions about diagnosis and operative treatment that interleave the text.

THE RELATIONSHIP OF FRACTURE OF THE LOWER EPIPHYSIS OF THE TIBIA TO ARREST OF GROWTH OF THE BONE.*

BY R. C. ELMSLIE, M.S., F.R.C.S.,

Orthopædic Surgeon, St. Bartholomew's Hospital, London.

An x-ray photograph of an injury to the lower epiphysis of the tibia was recently shown to me by Mr. H. Blakeway, and although I do not suppose that the injury is new, in the sense of being unrecorded, I think that it is worth describing, as it gives an explanation of the appearances seen in many cases of partial arrest of growth of the bone at this point. (Fig. 1.)

Fig. 1.—X-ray photograph of the ankle showing vertical fissure through lower epiphysis of the tibia.

The accident occurred to a young man, aged 17, whilst skating, the foot being twisted violently inwards. The x-ray shows a vertical fissure in the lower epiphysis of the tibia opposite the prominent outer side of

* A paper read before the British Orthopædic Association.

the upper articulated surface of the astragalus. Such an injury must have been produced by an inward leverage of the internal malleolus, and in order that a fissure of the nature shown might occur it is essential that it should be accompanied by a further fissure running inwards in the manner shown in the diagram. This fissure is too slight to be shown in the x-ray, but it would almost certainly occur through the line of least resistance, that is, through the new bone close upon the diaphyseal side of the epiphyseal cartilage. We have here, therefore, a vertical fissure through the epiphysis at its thinnest point, accompanied by a partial separation of the inner part of the epiphysis. (See Fig. 2.)

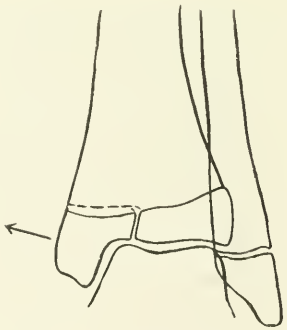


FIG. 2.—Diagram of the complete fracture. The dotted line represents the presumed completion of the line of fracture; the arrow, the direction of the force.

Arrest of growth of a bone due to injury in the region of an epiphyseal line is due to the fact that such an injury leaves a scar across the new bone at the extremity of the diaphysis. The actual growth of the bone at the epiphyseal line is due to the ingrowth of vascular loops furnished with osteoblasts from the cancellous spaces of the extremity of the diaphysis into the proliferating cartilage of the epiphyseal line. The existence of a scar will diminish the rapidity of such an ingrowth or, perhaps, even stop it altogether. Therefore, in this

case we may expect an arrest or a diminution of the growth at the inner side of the epiphyseal line, with a normal rate of growth at the outer part of this line. This is exactly what is seen in those cases of arrest of growth of the lower end of the tibia in which a varus deformity arises. I here show an x-ray photo of such a case of epiphyseal interference, in which it will be seen that there is a sclerosed patch just in the situation which would have been occupied by a fracture such as I have described, and an evident difference in the rate of growth at the inner and outer part of the epiphyseal line. (Fig. 3.)

Of course I am aware that in order to prove conclusively this theory of the origin of interference with the growth of the lower end of the epiphysis I should show a case of this fracture followed, after an interval by arrest of growth and varus deformity. But such a case may be difficult to find, for the injury is, no doubt, uncommon, and in most cases of arrest of growth there is no radiographic evidence of the nature of the original injury. I am in hopes that some of my audience may be able to complete the case by finding and recording a complete case.

FIG. 3.—Arrest of growth of the lower epiphysis of the tibia with varus deformity.

DISCUSSION.

Mr. McMurray: I have had a case under notice for five years which had the same injury as Major Elmslie has described, the fibula now being almost on the sole. Osteotomy has been done on tibia on the inner side on three occasions, and it is perfectly straight and shows a mark along the epiphyseal line due to the fibrous partition. It was a transverse fissure, right across, but the edge of the epiphysis was broken towards the right fibula and there is a transverse fracture between.

Mr. Bennett: I think we should be able to find many of these cases among our patients, that is, those in which we have manipulated with a wrench and probably got, as a result, some fracture. I think in many cases we do alter the epiphyseal line of the lower extremity. I have seen cases in which there has been prolongation of the fibula.

General Sir Robert Jones: On more than one occasion I have separated the epiphysis in some of my rather rough and primitive surgery, yet in no instance have I noticed any bad effect. What struck me as extraordinary and interesting is, that I have notes of cases, and other cases I remember, which had suppuration and separation of the epiphysis, and growth has occurred just the same. Of course one has noted cases where growth has been interfered with by an injury of the epiphysis. In one case, I remember, a huge abscess was opened and I found the epiphysis was separated. Seven years afterwards I examined the limbs and there was not the slightest difference in their length. So it is probable that many injuries of the epiphysis do occur, which do not, however, rise up like a ghost before us in later days.

The President: As confession seems to be rather the order of the day, I may confess to having had an exactly similar experience to Sir Robert Jones'. I have, several times, separated the epiphysis of the lower end of the tibia in forcible manipulation of club-foot but have never been able to find any alteration in the growth afterwards. It is rather sad that both the President and the Vice-President of this Association should be guilty of rough and primitive surgery, but the fact remains.

RESULTS OBTAINED BY TREATING WEAK FEET ALONG MILITARY LINES AMONG CIVILIANS.

BY LEO C. DONNELLY, M.D., DETROIT,
Ex-Director Orthopædic Surgery, Camp Wheeler.

THE author has been acting as orthopædic member to Medical Advisory Board No. 21, and as medical member to Local Board 10, for the past several months. This work has brought him in contact with nearly as many cases of weak feet as did his active military service in Base Hospital No. 43 Bis, in France, during 1916 and 1917, and later as director of orthopædic surgery at Camp Wheeler. During the months of June and July, one saw as high as fifty cases a day of weak feet at the Medical Advisory Board, and ten to twenty per day at the Local Board.

Nearly 100 per cent. of the registrants with defective feet appeared for examination wearing the so-called English walking shoe, a narrow-toed shoe. On questioning those who appeared wearing a broad-toed shoe, nearly all gave the history of having worn previously the narrow-toed shoe. Many still wore the narrow-toed shoe as a dress shoe. A large number of men rejected by the local Navy and Marine recruiting stations presented themselves at the office, hoping that some method could be devised to build up their feet so that they could pass the physical examination for induction in the respective services.

The author, being conversant with the method employed by the American, British and French Medical Corps, thought that similar methods could be applied to civilians with equally good prospects of success. The lack of military control over the patients was counterbalanced by the desire of these young men to get into service. Civilian life being less arduous than military life also worked to the patient's advantage.

The patients were told that their feet were weak chiefly because of poor-fitting shoes, faulty standing posture and undeveloped foot muscles. The muscle pull of the foot flexors, foot extensors and foot supinators were taken each week and the patient kept informed of the progress. He was told that the military shoe was considered the most perfect shoe made and that he must wear that shoe all of the time while under treatment. The patients were fitted according to the rules laid down by the Surgeon-General's Office, excepting that they did not have a 40-pound pack upon their back. Their former shoes were

too short or too narrow, many both too short and too narrow. All complained that the new army shoes were too large, but admitted that they were the most comfortable that they had worn. Since bromidrosis was pronounced with these patients, they were supplied with a formaldehyde solution in which to soak their feet, and with a foot powder containing boric acid and salicylic acid. The bromidrosis usually disappeared within two weeks. The patients were shown on the skeleton that the arrangement of the metatarsals and phalanges of the foot is similar to the corresponding bones of the hand; that since the bone, blood, nerve and muscle supply of these parts is very similar, one should expect that training would tend toward making their function similar. They were told that in order to train the muscles of their feet properly, they had to stand with feet parallel, throwing the body weight toward the outer border of the feet, that when the muscles of the feet were well developed by exercises, the muscles would fill the spaces of their feet by their bulk, and that their contractile power would approximate the bases of the arches of the feet, and then their weak feet would be cured. They were also informed that shifting their body weight would temporarily produce new tender points and that corns and callouses did not exist among properly shod soldiers, and that theirs would disappear.

In order to allow the patient to intelligently coöperate he was given a printed sheet with full directions and explanations. He was to do his exercises 30 times, morning and night, and as often during the day as practicable. The five principal exercises consisted of flexion and extension of the toes over a board, separating toes, standing with feet parallel fourteen inches apart and internally rotating legs and supinating feet until the toes touched and the body weight was entirely on the outer borders of the feet, sitting with knees crossed and rotating foot inward in large circles, seeing that each tendon showed in turn; sitting, feet widely spread, toes in, forcing feet forward in a crescentic manner until toes touched, then pulling them back in opposite manner. Many other less valuable exercises were added for their psychic effect. Those that reported three times a week progressed proportionately faster than those who reported once a week. Every patient, except one, passed the Navy and Marine Corps examination within two months, the majority within three weeks; over fifty have passed the Marine Corps alone.

These patients were young Americans who wanted to enlist and who felt that to be drafted was a disgrace. They were keen for the service and would do anything asked of them if it aided their chances

of passing. All feet improved remarkably in muscle strength, some arches raised 5/8 inches by actual measurement. The gratefulness expressed by these 18 and 19-year-old boys on passing into their respective corps amply repaid one for the energy expended in directing them.

The same plan has been tried on older patients, with satisfactory results. They have not the fire of youth and are willing to stop exercising as soon as the pain and foot disability are relieved. This plan of treatment has given definitely better results than the author's former method of supplying arches made from casts. In fact the author is attempting to eliminate foot plates as much as possible.

In closing, it seems to the author that the Government, for military reasons, should standardize the lasts upon which shoes are built, so as not to allow people to ruin their feet. A national board, having an orthopædic member from the Surgeon-General's office, could pass on lasts before the shoes were built.

The following brief case histories are appended:

	Foot Flexors	Foot Supinators	Foot Extensors	Bromidrosis	Calluses	Comfort
Case 1						
Aug. 8	24 lbs.	22 lbs.	32 lbs.	Severe	Not noted	Tired
Aug. 28	46 lbs.	48 lbs.	46 lbs.	Improving		Less tired
Sept. 4	46 lbs.	48 lbs.	56 lbs.	None		Not tired
Sept. 9	62 lbs.	56 lbs.	70 lbs.	None		Feels fine
Sept. 10	Passed Navy examination. Previously rejected.					
Case 2						
July 31	20 lbs.	20 lbs.	24 lbs.	Severe	Ant. arch	Burns, tired
Aug. 8	30 lbs.	30 lbs.	34 lbs.	None	Small	Less tired
Aug. 15	Passed Navy examination, previously rejected, wore arch supporters.					
Case 3						
Aug. 1				Severe	No record	Tired
Aug. 6				Improved		Feels fine
Aug. 23	46 lbs.	48 lbs.	48 lbs.	None		Feels fine
Sept. 5	52 lbs.	58 lbs.	60 lbs.	None		Feels fine
Sept. 15	64 lbs.	68 lbs.	64 lbs.	None		Feels fine
Sept. 16	Passed Navy examination, previously rejected.					
Case 4						
Aug. 8	28 lbs.	18 lbs.	40 lbs.	Severe	Ant. callous	Tired
Aug. 15	40 lbs.	32 lbs.	50 lbs.	Less	Less	Improved
Aug. 19	42 lbs.	38 lbs.	50 lbs.	Less	Less	Feels good
Aug. 30	56 lbs.	48 lbs.	58 lbs.	None	None	Feels good
Sept. 5	Passed Navy examination, previously rejected.					

SPLINT DEVISED FOR TREATMENT OF STIFF METACARPO-PHALANGEAL JOINTS.

BY FRANK E. LEWIS, CAPTAIN, M. C., U. S. A., LIVERPOOL,
Alder Hey Military Hospital.

THIS splint was devised for the treatment of stiff metacarpo-phalangeal joints. The large number of such cases has given the surgeon much trouble, inasmuch as treatment has produced very slow and uncertain results.

These stiff joints occur in practically all cases which require long application of splints to the forearm and hand, and persist in spite of massage or manipulation.

Compound fractures of the forearm, involving tendons, fracture of the carpal bones, with tendon involvement, injury to the metacarpals and paralysis of muscles from nerve injury all tend to bring about

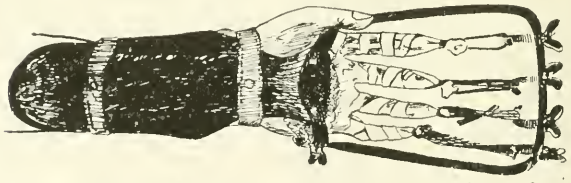


FIG. 1.—Under view, showing splint applied with extension to finger.

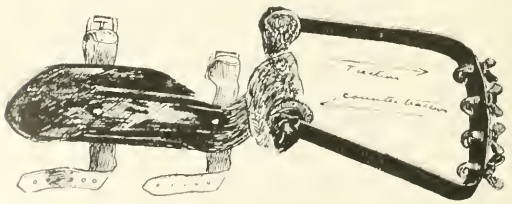


FIG. 2.—Side view, showing method of fixation to forearm and dorsal flexion of wrist.

atrophic change in the metacarpo-phlangeal joint, with a resultant hyperextension and dislocation. At the same time, the anterior arch of the hand becomes convex and painful. In most of these cases there is also a stiff wrist.

In devising this splint, the principal object was to get flexion of the metacarpo-phalangeal joints in the shortest time possible, by following the mechanical principle of traction and countertraction. Diagram No. 2 shows the splint in outline, demonstrating the method of attaining traction and countertraction.

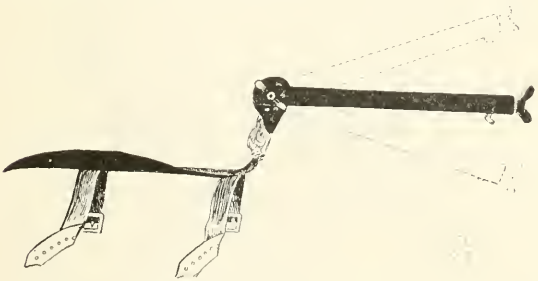


FIG. 3.—Cross section, showing method of flexing fingers at metacarpo-phalangeal joints while in extension.

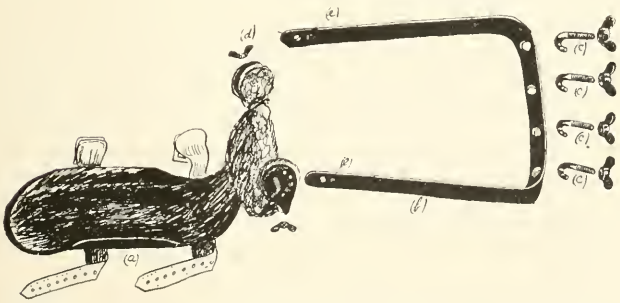


FIG. 4.—Showing individual parts of splint: (*a*) Splint for dorsal flexion of wrist; (*b*) Frame for flexion of fingers at metacarpo-phalangeal joints; (*c*) Extension screws. (Individual as desired.); (*d*) Screws for flexion frame; (*e*) Pin for fixation of frame in position desired.

FIG. 5.

As was mentioned above, we find a stiff wrist in a majority of these cases—the dorsal flexion is obtained, first, by the cock-up part of the splint and, secondarily, by the gradual countertraction marked by the arrow.

As the traction is applied to the fingers, there is a resultant countertraction on the wrist, producing dorsal flexion.

The bar which comes just back of the metacarpal heads is curved so as to preserve the natural anterior arch of the palm. The extension is applied to the fingers for 48 hours, then the flexion frame, as demonstrated in figure No. 3, is lowered gradually each day and held in position by thumb screw (d) in diagram No. 4. It is essential that the extension straps should be carefully applied to the fingers so that there will be no slipping. Adhesive strapping should be used.

The stiffness of the phalangeal joints improves as the deformity of the metacarpal joints is reduced, and can be hastened by loosening the individual extensions daily for about ten minutes, while the fingers are being massaged. The results have been particularly gratifying in long-standing cases.

FIG. 6.

The x-ray showing the splint applied was taken 72 hours after application. Comparison with the x-ray of the same patient 14 days after application of the splint, shows how well the joints have been reduced, there being 60° of voluntary flexion.

The flexion frame can be applied with equal success to flexion deformities by reversing the procedure, *viz.*, by applying the frame in flexion and gradually extending fingers by raising the frame.

THE CHANGES PRODUCED IN THE GROWING BONE AFTER INJURY TO THE EPIPHYSEAL CARTILAGE PLATE.

BY S. L. HAAS, M.D., SAN FRANCISCO,

Captain, Medical Corps, U. S. Army.

[From the Pathological Laboratory and the Surgical Pathological Laboratory of Leland Stanford, Jr., University School of Medicine.]

(*Concluded from page 179.*)

Experiment 65. 15 Days. Dog 72-56.

Operation. Removed the proximal diaphyseal end of the metacarpal III., of the left fore foot. The total length is 2.2 cm., while the part remaining is 1.25 cm. The animal died at the end of 15 days.

Gross Findings. There is good healing. The bone on longitudinal section appears paler than normal. The epiphyseal cartilage plate appears normal. The measurements are: Metacarpal III., at end of experiment. 1.3 cm.: metacarpal III., at operation, 1.25 cm.=0.05 cm. Thus there is no growth in this short period.

Experiment 66. 42 Days. Dog 108-71.

Operation. Removed the proximal two-thirds of the metacarpal III. of the right fore foot. The total length of the bone is 2.8 cm., while the part remaining is 1.2 cm. The animal died at the end of 42 days.

Gross Findings. There is a change in the shape and size of the bone. The cut end is small and rounded off, but possesses medullary contents up to the end. The cut end is small and epiphyseal cartilage plate appears normal. The measurements are: Metacarpal III., at end of experiment. 1.85 cm.; metacarpal III., at operation, 1.2 cm. Thus there is 0.65 cm. increase in length since the operation. The normal growth is 3.45—2.8=0.65 cm.

Experiment 67. 50 Days. Dog 97-68.

Operation Removed the proximal part of the metacarpal IV. of the right fore foot. The piece remaining measures 0.7 cm.

Gross Findings. There is good healing. The epiphyseal cartilage plate is of normal appearance The cut end is pointed and there is a tendency to form a new cortex. The measurements are: Metacarpal IV., at end of experiment. 1.1 cm.; metacarpal IV., at operation, 0.7 cm.=0.4 cm. Thus there is only relatively a small amount of growth.

Microscopical Findings. The epiphysis appears normal. The epiphyseal cartilage plate is not so regular as normal, and there is not the usual active ossification of the cartilage columns of the epiphysis. The cut end of the bone has assumed a conical shape and is enclosed by fibrous tissue. No definite cortex is present at the end of the bone but there are some irregular pieces of osseous tissue within the limiting fibrous tissue.

Experiment 68. 68 Days. Dog 119-75.

Operation. Removed the proximal portion of metacarpal III. of the left fore foot up to the metaphyseal region. The total length of the bone is 3.2 cm., while the piece remaining is 1.65 cm.

Gross Findings. The general appearance of the bone, including the epiphyseal cartilage plate and marrow is normal. The measurements are: Metacarpal III., at end of experiment, 2.35 cm.; metacarpal III., at operation, 1.65 cm.=0.7 cm. of growth. The roentgenogram shows the end of the bone limited by cortical bone. The medullary canal has a fairly normal appearance. (See Fig. 10.) The normal growth is 4.2—3.2= 1.0 cm.

Experiment 69. 126 Days. Dog 88-64.

Operation. The basal portion of metacarpal IV. of the left fore foot is removed up to the metaphyseal region. The part remaining measures 1.0 cm.

Gross Findings. There is good healing. The bone has increased in length but is narrower at the cut end. This is well shown in the roentgenogram The epiphysis of the operated bone is only slightly smaller than normal. (See Fig. 11.) The measurements are: Metacarpal IV., at the end of experiment, 2.25 cm.; metacarpal IV., at operation, 1.00 cm. Thus there is an increase of 1.25 in length since the time of operation.

SUMMARY ON CUTTING THROUGH THE METAPHYSEAL REGION AND REMOVING THE PROXIMAL PORTION.

In practically every instance there is evidence of growth. If the incision approaches close to the epiphyseal cartilage plate there is a considerable hindrance of growth. The growth is not so great as normal, due to two factors. First, because of the destruction of the vascular supply coming from the nutrient artery and part of the direct supply to the epiphyseal cartilage plate. Secondly, because of the direct injury to the cartilage plate itself.

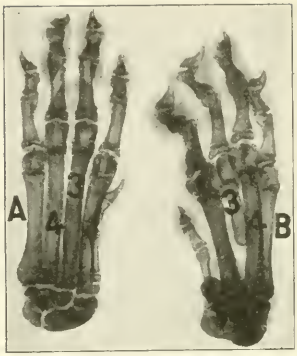


FIG. 10.—Experiment 68. 68 days. Dog 119-75. Removal of the proximal portion of the metacarpal. Right in photograph, B, third bone from the right, 3, is the operated bone. Notice how the cut end of the bone is enclosed with an even and rounded new cortex of normal structure.

FIG. 11.—Experiment 69. 126 days. Dog 88-64. Removal of the proximal portion of the metacarpal. The cut end of the operated bone, 4, has assumed a pointed form. There is considerable rarefaction of the shaft most likely due to destruction of some of the blood supply.

TABLE XVII.

EXP. NO.	DOG NO.	DURATION	GROWTH OF OPERATED	LOSS OF GROWTH	GROWTH OF NORMAL
64	76-5	15 days	0.05 cm.	0	0
65	72-56	15 "	0.05 cm.	0	0
66	108-71	42 "	0.65 cm.	0	0.65 cm.
67	97-68	50 "	0.4 cm.	?	?
68	119-75	68 "	0.7 cm.	0.3 cm.	1.0 cm.
69	88-64	120 "	1.25 cm.	?	?

The following additional experiments have been performed and will be described in order.

GROUP VII. BORING INTO AND REMOVING THE CANCELLOUS BONE OF THE EPIPHYSIS.

1. Boring Directly Into the Epiphysis.

Method. After exposing the epiphysis of the selected bone a small hole is made through the cortex of the epiphysis. By means of a small curette the cancellous bone of the epiphysis is removed.

Experiment 70. 33 Days. Dog 114-73.

Operation. Removed the cancellous tissue from the epiphysis of the metatarsal IV. of the left hind foot. The bone measures 2.9 cm.

Gross Findings. There is good healing. The opening in the epiphysis is still visible. There is some new bone within the cortex. The measurements are: Metatarsal IV., at end of experiment, 3.2 cm., metatarsal IV., at operation, 2.9 cm. There is 0.3 cm. of growth since operation. The normal growth is 3.2—2.9=0.3 cm.

Microscopical Findings. There is considerable cancellous bone in epiphysis. The opening in the cortex is filled with fibrous tissue and some cartilagenous tissue. The epiphyseal cartilage plate appears fairly normal. The remainder of the bone appears normal.

Experiment 71. 65 Days. 107-70

Operation. Scraped out the cancellous bone of the epiphysis of the metatarsal IV. of the left hind foot. The bone measures 3.1 cm. The animal died at the end of 65 days.

Gross Findings. The joint capsule is thickened. On longitudinal section the epiphysis is found to be practically normal in appearance. There is no evidence of the hole in the cortex. The measurements are: Metatarsal IV., at the end of experiment, 3.95 cm., metatarsal IV., at operation, 3.1 cm. Thus there is 0.85 cm. of growth. The normal growth is 4.0—3.1=0.9 cm.

Microscopical Findings. The general appearance of the epiphysis is normal. The hole in the cortex cannot be made out. There is a defect in one portion of the epiphyseal cartilage plate. This might be due to an accidental injury at the time of operation. The ossifying buds of the metaphysis are shorter and fewer than normal.

SUMMARY ON DIRECTLY REMOVING TISSUE OF THE EPIPHYSIS

There is no hindrance of growth after such an operation. This would naturally be expected as there is no injury to the epiphyseal cartilage plate, and but slight injury to the epiphyseal blood supply.

TABLE XVIII.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
70	114-73	33 days	0	0	0.3 cm.
71	107-60	65 "	0.05 cm.	0.85 cm.	0.9 cm.

2. Boring into the Epiphysis Through the Epiphyseal Cartilage Plate.

Method. A small opening is made through the cortex of diaphysis, near the metaphysis. Then by means of a small curette an opening is made through the epiphyseal cartilage plate in the epiphysis. The cancellous bone is then removed from the epiphysis. The wound is closed in the usual manner. In this experiment there is practically no destruction of the epiphyseal blood supply.

Experiment 72. 16 Days. Dog 64-58.

Operation. Bored into the epiphysis of the metacarpal III. of the left fore foot through the epiphyseal cartilage plate.

Gross Findings. The bone is bent just on the diaphyseal side of the metaphysis. On longitudinal section it is noticed that only the central portion of the epiphyseal cartilage plate is removed. The marrow of the epiphysis has a fairly normal color and appearance. The measurements are: Metacarpal III., left, 2.05 cm.; difference, 0.25 cm. right, 2.3 cm. Thus there is a loss in growth of 0.25 cm.

Microscopical Findings. There is a defect in the epiphyseal cartilage plate which is occupied by marrow and trabeculae of normal structure. There is no difference in the structure of the epiphysis except a diminution in the number of trabeculae. The hole in the cortex of the diaphysis is filled with fibrous tissue.

Experiment 73. 28 Days. Dog 145-85.

Operation. Performed a similar operation as in Experiment 72 upon the metacarpal III. of the left fore foot. The length of the bone at operation is 2.3 cm. The animal died at the end of 28 days.

Gross Findings. On longitudinal section a yellowish area is noticed within the epiphysis. The epiphyseal cartilage plate is straight instead of curved and is not so distinct as normal. There is a small defect in the central part. The remainder of the bone appears fairly normal. The measurements are: Metacarpal III., left, 2.6 cm.; difference, 0.6 cm.; right, 3.2 cm. Thus there is 0.6 cm. loss of growth.

Microscopical Findings. There are very slight changes in the epiphysis. There is a defect in the center of the epiphyseal cartilage plate which is filled with marrow and trabeculae. The cartilage plate is narrower than normal and the columns of cartilage are irregular. There is almost a complete absence of the ossifying columns of the metaphysis and the general indications point to a cessation of growth The diaphysis appears fairly normal.

Experiment 74. 30 Days. Cat 74-47.

Operation Bored into the diaphysis of metatarsal III. of the right hind foot and then curetted out the epiphyseal cartilage plate from the inside. The animal died at the end of 30 days.

Gross Findings. The measurements are: Metatarsal III., left, 2.5 cm.; difference, 0.1 cm.; right, 2.4 cm. There is practically no difference between the two sides. There has evidently been little growth even in the normal bones.

Experiment 75. 28 Days. Dog 94-66.

Operation. Bored into the diaphysis of the metatarsal III. of the right hind foot and scraped out the epiphyseal cartilage plate from the inside. The animal died at the end of 38 days.

Gross Findings. There is a distortion of the head of the bone on the shaft. On longitudinal section the central part of the epiphyseal cartilage plate is found to be occupied by osseous tissue. The measurements are: Metatarsal III., left, 3.25 cm.; difference, 0.65 cm.; right, 2.6 cm. There is a shortening of 0.65 cm., a part of which is due to the distortion of the head of the bone on the shaft.

Experiment 76. 41 Days. Dog 78-60.

Operation. Bored into the diaphysis of the metatarsal III. of the

left hind foot and scraped out the epiphyseal cartilage plate from within. The animal died at the end of 41 days.

Gross Findings. There is an apparent shortening of the operated bone. On longitudinal section the epiphyseal cartilage plate is found to be almost entirely absent, its place being occupied by osseous tissue. The measurements are: Metatarsal III., left, 3.1 cm.; difference, 0.5 cm.; right, 3.6 cm. Thus there is a loss of 0.5 cm., due to the destruction of the epiphyseal cartilage plate. The Roentgenogram shows the shortening and also the defect in the epiphyseal cartilage plate and the tract of new tissue along the puncture, through the diaphysis into the epiphysis. (See Fig. 12.)

FIG. 12.—Experiment 76. 41 days. Dog 78-60. Removal of the epiphyseal cartilage plate by boring into the diaphysis and scraping the cartilage from within. Right in the photograph, B, third bone from the right is the operated bone. Notice the loss of growth, ascertained by comparing with its fellow, A, which it should equal in length. The course of the puncture is shown in the shadow in the upper portion of the diaphysis. This experiment shows that an injury to the plate, even with an intact blood supply, will cause growth disturbance.

SUMMARY ON THE REMOVAL OF THE EPIPHYSEAL CARTILAGE PLATE FROM WITHIN.

In five of the six experiments there is a decided hindrance in growth of the bone following the removal of a portion of the epiphyseal cartilage plate from within. This shows that even with an adequate blood supply from without there will be a loss in growth if the epiphyseal cartilage plate is injured. This set of experiments shows the inadvisability of operating through the epiphyseal cartilage plate, as has

been advised in the case of tuberculosis of the head of the femur, or in other bones, especially if it necessitated the injuring of an epiphyseal plate, which is most important in the production of the increase in length.

TABLE XIX.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
72	64-58	16 days	0.35 cm.	?	?
73	145-85	28 "	0.6 cm.	0.3 cm.	0.9 cm.
74	74-47*	30 "	0.1 cm.	?	?
75	94-66	38 "	0.65 cm.	0.1 cm.	0.75 cm.
76	78-60	41 "	0.5 cm.	0.5 cm.	1.0 cm.

*Cat

GROUP VIII. DIRECT TRAUMA TO THE EPIPHYSEAL CARTILAGE PLATE.

1. Crushing the Epiphyseal Cartilage Plate.

Method. The epiphyseal cartilage plate is exposed and then by means of hemostatic forceps the epiphyseal cartilage plate and adjacent bony tissues are crushed.

Experiment 77. 76 Days. Dog 35-76.

Operation. After exposing metatarsal IV. of the right hind foot, the epiphyseal cartilage plate is crushed by means of a hemostat. This procedure necessarily injures the adjacent metaphysis and epiphyseal cancellous bone. The bone measured 2.8 cm. The animal died at the end of 76 days.

Gross Findings. There is good healing. The measurements are: Metatarsal IV., left, 4.55 cm.; difference, 0.5 cm.; right, 4.05 cm. Thus there is a loss of 0.5 cm. in length since the operation. The growth of the normal bone is 1.75 while that of the operated is 1.25 cm. So that in this case there is only a partial hindrance of growth. The roentgenogram shows the difference in size of the normal and operated bone. The greater part of the epiphyseal cartilage plate is intact and has a fairly normal structure. The remainder of the bone appears normal.

Experiment 78. 81 Days. Dog 16-52.

Operation. Crushed the epiphyseal cartilage plate of metacarpal III. of the right forefoot. The bone measures 2.7 cm. in length. The animal was killed by illuminating gas, after 81 days.

Gross Findings. There is some distortion of the articular surface of the operated bone. On longitudinal section there is found to be almost a complete absence of the epiphyseal cartilage plate. The epiphy-

sis itself is somewhat distorted in shape. The metaphysis is denser than normal. The measurements are: Metacarpal III., left, 4.85 cm.; difference, 1.7 cm.; right, 3.15 cm. Thus there is a loss of 1.7 cm. in length since the operation. The growth of the operated bone is 3.15—2.7=0.45 cm., while the normal growth is 4.85—2.7=1.15 cm. Thus in this particular case there is more hindrance in growth than in Experiment 77. Naturally this must be due to a more severe injury to the epiphyseal cartilage plate at the time of operation. The Roentgenogram shows almost an entire disappearance of epiphyseal cartilage plate, also the marked shortening and smaller size of the epiphysis. (See Fig. 13.)

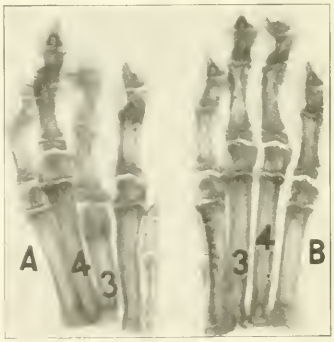


FIG. 13.—Experiment 78. 81 days. Dog 16-52. Crushing the epiphyseal cartilage plate. Left in photograph A, third bone from the left is the operated bone, 3. The epiphseal cartilage plate is ossified and there is a marked loss of growth. Compare 3 and 4, as they are normally equal in length.

Microscopical Findings. The epiphysis has a fairly normal structure. The epiphyseal cartilage plate shows a defect, also a marked distortion. The columns are shorter and irregularly placed, and there is no ossifying buds extending into the metaphysis.

SUMMARY ON DIRECT TRAUMA TO THE EPIPHYSEAL CARTILAGE PLATE.

Although the number of experiments are few, one can make certain definite deductions as to the effects of a crushing injury to the epiphyseal cartilage plate. There is always a hindrance in growth which naturally depends upon the severity of the injury of the epiphy-

seal cartilage plate. The more cells destroyed the greater the amount of growth disturbance. Even in a fairly severe injury there is not a complete cessation of growth, as some of the cells seem to retain a limited property of producing an increase in length.

TABLE XX.

EXP. NO.	DOG NO.	DURATION	LOSS OF GROWTH	GROWTH OF OPERATED	GROWTH OF NORMAL
77	35-76	76 days	0.5 cm.	1.25 cm.	1.75 cm.
78	16-52	81 "	1.7 cm.	0.45 cm.	2.15 cm.

2. Cutting Out a Wedge from the Region of the Epiphyseal Cartilage Plate.

Method. After exposing the epiphyseal cartilage plate by means of a sharp scalpel, a wedge of cartilage is cut out.

Experiment 79. 81 Days. Dog 17-52.

Operation. The Metatarsal III. of the left hind foot is exposed. A wedge which extended about one-half way through the cartilage plate is then excised. The length of the bone is 3.0 cm. The animal was killed by illuminating gas at the end of 81 days.

Gross Findings. There is good healing. The articular cartilage has

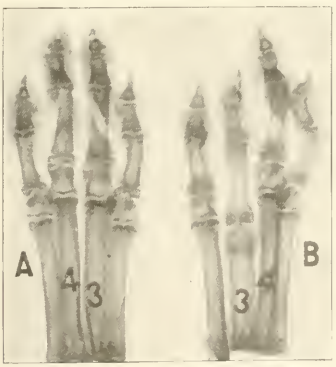


FIG. 14.—Experiment 79. 81 days. Dog 17-52. Cutting out of a wedge from the epiphyseal cartilage plate. Right in photograph B, third bone from the right, 3, is the operated bone. Notice the marked disturbance in growth following the removal of a wedge from the cartilage. The epiphyseal cartilage plate has undergone an early ossification and there is a broadening of the diaphysis.

been altered in shape. The epiphyseal cartilage plate is distorted. The dorsal portion which was excised shows no evidence of regeneration. (See Fig. 14.) The measurements are as follows: Metatarsal III., left, 3.2 cm.; difference, 1.9 cm.; right 5.1 cm.; Thus there is a loss of 1.9 cm. in length of the operated bone. The growth of the operated bone is 3.2—3.0=0.2 cm., while that of the normal bone is 5.1 cm.—3.0 cm.=2.1 cm.

Microscopical Findings. The articular cartilage is somewhat uneven but of fairly normal structure. The trabeculae and marrow of the epiphysis are relatively normal. The epiphyseal cartilage line appears as a small remnant on the plantar side. Even this portion of the cartilage has lost considerable of its normal structure and arrangement and is undergoing ossification. The diaphysis is normal.

SUMMARY ON CUTTING A WEDGE SHAPED PIECE FROM THE EPIPHYSEAL CARTILAGE PLATE.

In the single experiment of this nature the injury was so severe as practically to cause a cessation of growth. The portion of cartilage plate remaining did not possess the power to cause a compensatory growth, in fact, it seems to have undergone a rapid calcification.

RÉSUMÉ.

1. Simple Cross Incisions. Simple cross incisions through the epiphysis distal to the epiphyseal cartilage plate, as well as those through the metaphysis or diaphysis, cause no disturbance in longitudinal growth. A cross incision through the epiphyseal cartilage plate always causes a loss of growth, the loss being directly proportional to the degree of injury to the cartilage cells. It is possible to make a separation in the line of cleavage of the cartilage plate without causing any disturbance to growth, but, as a rule, even in cleavage separations there is a hindrance of growth.

2. Longitudinal Incisions. Longitudinal incisions extending through the epiphysis and epiphyseal cartilage plate produce no disturbances in growth. If the longitudinal incision extends through the entire length of the bone there is a slight loss of growth. This loss must be ascribed to an injury to some of the large blood vessels which supply the epiphyseal cartilage plate. There is also the possibility of the additional trauma of the two halves rubbing together because of the greater mobility produced by the incision.

3. Cross Incisions and Raising the Distal Fragment. If the portion distal to the epiphyseal cartilage plate is raised there is no disturbance in growth, unless the incision comes near the vital growing

cells of the epiphyseal cartilage plate. When the incision passes through or a separation is made in the line of cleavage of the epiphyseal cartilage plate then there is a marked hindrance in growth. A small amount of growth occurs after this disturbance, which may be ascribed to potential cell growth of the injured cartilage cells. If the incision passes proximal to the epiphyseal cartilage plate and the distal segment is raised, including the epiphyseal cartilage plate, there is practically a complete cessation of growth. The later experiment is a complete reimplantation of the epiphyseal cartilage plate and epiphysis.

4. Longitudinal Incisions Through the Epiphyseal Cartilage Plate with Removal of One of the Halves. If one lateral half of the epiphysis is removed up to the epiphyseal cleavage line there takes place subsequently little growth in length of that bone. If the section includes a portion of the metaphysis there is likewise a very great loss in length growth. If the entire lateral half of the bone is removed there results a complete cessation of growth of the remaining segment. One would hardly expect to find such a marked degree of disturbance —following the removal of one half of the epiphysis. This disturbance must be ascribed to injury to the blood supply, trauma to the cartilage cells, and disturbance in the growth equilibrium. Because of these facts, it is inadvisable to remove such segments for transplantation as suggested by some investigators.

5. Cross Incisions with Removal of the Distal Segment. There is practically no disturbance in growth when the portion removed is distal to the epiphyseal cartilage plate. If the entire epiphysis up to the epiphyseal cartilage plate is removed then there is practically a complete cessation of growth. In some cases there is an irregular outgrowth of bone, pointed in form, and entirely unlike that which occurs at the normal epiphyseal cartilage plate. If the epiphysis, including the metaphysis is also removed, then there is also a complete cessation of purposeful longitudinal growth. There might occur some irregular sprouting at the cut end, such as one would get along a periosteal remnant.

6. Cross Incisions with Removal of the Proximal Segment. In the case where the separation is made in the line of cleavage with removal of the proximal segment and leaving the epiphysis, there is practically a complete cessation of longitudinal growth. That the intact cartilage of the epiphyseal cartilage plate ceases to functionate seems rather peculiar, but it must be ascribed to the fact that the blood supply to the epiphyseal cartilage plate is almost entirely destroyed in this operation. This de-

destruction of the blood supply, with a certain amount of unavoidable injury to the epiphyseal cartilage plate is sufficient to explain the loss of growing power. If the separation is made in the metaphysis or diaphysis there is a continuance of growth in every instance. However, if the incision approaches too close to the epiphyseal cartilage plate, then there will be disturbance in growth because of the injury to the blood supply of the epiphyseal cartilage plate.

7. *Boring into the Epiphysis.* If one bores a hole directly into the epiphysis and scrapes out the cancellous bone there will be no disturbance in length growth. If, however, a hole is bored into the metaphysis and the cancellous bone of the epiphysis is removed from within, by means of a hole made through the epiphyseal cartilage plate, there is a loss of growth in almost every instance. This is due to the injury to the important cells of the epiphyseal cartilage plate. It is important to bear this fact in mind in trying to operate upon the epiphysis through the epiphyseal cartilage plate, as has been suggested in the cure of tuberculosis of the head and neck of the femur, by boring through the epiphyseal cartilage plate of the neck of the femur; also a like care in any operation involving the epiphyseal cartilage.

8. *Direct Trauma to the Epiphyseal Cartilage Plate.* A direct crushing injury to the epiphyseal cartilage plate always causes a loss of growth. The greater the injury to the cartilage cells and destruction of the blood supply, the greater the loss of growth. In the case of a very severe crushing injury there might not be a complete cessation of growth, as some of the cells might retain their vitality and be capable of proliferating. It is known from other experimental data that excision of the epiphyseal cartilage plate means the cessation of length growth, as length growth depends upon the integrity of this important cartilage. When a wedge of cartilage is removed there is almost a complete loss of growth, because the remaining cells have little power to cause length growth.

9. Having as a working principle that the most active and important elements necessary for longitudinal growth are located in the columns of cartilage of the epiphyseal cartilage plate the above experiments give further substantiation to this fact. Thus it is noticed that the nearer the injury comes to the cartilage columns the greater is the growth disturbance. Also that there is a relation between the degree of destruction of the cartilage columns and loss of growth. These two factors, along with disturbance in blood supply, form the more important principles governing bone growth. Previously it has been shown that destruction of the direct blood supply to the epiphyseal cartilage

plate has a marked hindering of longitudinal growth. Therefore, the result of any injury to the epiphyseal cartilage plate is dependent upon the degree and closeness of the injury to the columns of cartilage and to the amount of destruction of the direct blood supply to the region of the epiphyseal cartilage plate. It is hoped that these facts will be of value in helping to explain and anticipate the outcome, clinically, in injury to the epiphyseal cartilage plate; also to aid us in choosing, or of the advisability of resorting to, certain operative procedures that are associated with this important portion of the growing bone.

I wish to take this opportunity to express my thanks to Professor Ophuls of the Pathological Department for the privilege of performing these experiments under his supervision, and to Professor Blaisdell of the surgical laboratory for his assistance in the operative work and for the many courtesies extended to me during the period of investigation.

REFERENCES.

[1] HAAS, S. L.: The Localization of the Growing Point in the Epiphyseal Cartilage Plate of Bones. THE AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, 1917, xv, 563.

[2] HAAS, S. L.: The Relation of the Blood Supply to the Longitudinal Growth of Bone. THE AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, 1917, xv, 157 and 305.

[3] BIDDER, ALFRED: Experimente über die Künstliche Hemmung des Längen wachsthums von Röhrenknochen durch Reizung und Zerstörung des Epiphsenknorpels. *Arch. f. exp. Path. und Phar.*, 1873, l, 248.

[4] HELFERICH: Versuche über die Transplantation des Intermediärknorpels wachsender Röhrenknochen. *Deut. Zeitsch. f. Chir.*, 1899, li, 564.

[5] OLLIER (Quoted by JAHN): Traité éxperimental de la régénération des os et de la production artificielle du tissu osseux. Paris, 1867.

[6] HAAB (Quoted by JAHN): Experimentelle Untersuchungen über pathologischen Längenwachsthum der Röhrenknochen. *Medicin Centralblatt*, xii.

[7] VOGT, PAUL: Die traumatische Epiphysentrennung und deren Einfluss auf das Längeuwachsthum der Röhrenknochen. *Arch. f. klin. Chir., V. Langenbeck*, 1878, xxii, 343.

[8] DE PAOLI (Quoted by NAKAHARA): Del distacco traumatico del epifisi. Turin, 1882. Referat der *Arbeit von Escher, Zentr. f. Chir.*, 1883, x, 54.

[9] GHILLINI, C.: Experimentelle Untersuchungen über die mechanische Reizung des Epiphysenknorpels. *Arch. f. klin. Chir.*, 1893, xlvi, 844.

[10] JAHN, PAUL: Beiträge zur Kenntniss der histologischen Vorgänge bei der Wachsthumsbehinderung der Röhrenknochen durch Verletzungeu des Intermediärknorpel. *Morphologische Arbeiten Von Schwalbe*, I. 241.

[11] NOVÉ-JOSSERAND (Quoted by NAKAHARA): Troubles de l'acroissement des os par lésions des cartilages de conjugaison. Thèse de Lyon, 1893.

[12] ZOPPI (Quoted by NAKAHARA): Del processo intimo di guarigione del distacco epifisario. *Il Policlinico*, Anno viii, Vol. viii.

[13] RIEDINGER, J.: Experimentelle Untersuchungen über traumatische Epiphysistrennung. Beiträge zur Frage der Wachstumstörungen. *Arch. f. Orth. Mechanotherapie u. Unfallchir.*, 1909, vii, 128.

[14] NAKAHARA, T.: Heilungsvorgänge nach Durchschneidung des Intermediärknorpels bei Kaniuchen. *Arch. f. Orth., Mechanotherapie u. Unfallchir.*, 1909, vii, 105.

[15] MEISENBACH, R. O.: A Consideration of the Chemical and Mechanical Stimulation of Bone with Reference to Epiphyseal and Diaphyseal Lines. THE AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, 1910, viii, 28.

Book Review

The Suspension Treatment of Fractures. By P. Desfosses and Charles-Robert. Paris: Masson et Cie., 1918.

In a preface to this comprehensive monograph Pierre Duval says in part: "The method of suspension justly called the Anglo-American method, has not been, in France until now, the object of any complete description. Certain chapters are new: the total suspension of the patient in high fractures of the thigh; the organization of a total service of fractures for their general treatment by suspension, a fortunate simplification. The publishers have placed at the disposal of the authors a rich supply of illustrations. Every apparatus is represented as well as every instance of its application. The preferences of the authors are clearly for the Thomas splint. I can only approve of them. It is, in my opinion, the ideal apparatus because it adapts itself to all conditions of treatment. The book of Desfosses and Robert, coming from their wide experiences with the armies, ought to be a constant guide to all who wish to apply the extension-suspension method."

Although the subject is now rather hackneyed, the book is redeemed by the thoroughness in consideration of details and by the voluminous illustrations, some of which tell more at a glance than can be expressed in a page of description. Because of the many pictures, an abstract falls short in expressing the value of the book.

The suspension treatment seems to have been first used during the Balkan wars. The frame of that name was originally a little different from the form now in use, being low at the foot of the bed and high at the head and having a base for each upright piece to furnish stability. An innovation by Robert reduces the multiplicity of frames in equiping an entire ward for fractures. Instead of an independent frame for each bed, two long beams are put up along the row of beds, one at the heads and one at the feet, supported by a few uprights and coupled to one another by several beams, one or two for each bed, parallel with the beds. Thus we have a sort of compound frame under which is a row of ten to twenty beds. The several overhead beams connecting the two main supporting beams (corresponding to the long overhead bars of the single Balkan frame) are adjustable to any position or angle required by the necessities of the case under treatment.

Chapter II deals with fractures of the arm. The Thomas splint is featured emphatically. A variation which allows this splint to conform to the angle of abduction is the pivoting of the ring with the bars of the splint. This allows a better distribution of the counter pressure around the shoulder and axilla. Extension is obtained by adhesive attached to the forearm and tied to the end of the splint. The arm and splint are suspended by pulley and counter weight. If the reduction is good the arm is kept in this apparatus until union occurs, otherwise the Thomas splint is to be considered as temporary.

Blake's method for fractures of the arm is also described. It consists in extension by weights instead of counter pressure, flexion of the elbow with the forearm suspended vertically by pulley and weight, hammock suspension of the upper arm, and extension by adhesive to the upper arm through a pulley at the side of the bed. No rigid splints are used in this method of Blake's. An apparatus devised by Miss Gassette is also pictured. This defies description in words and appears clumsy and impractical. The traction is pictured as being obtained over a pulley and back to a band around the

patient's pelvis. Counter pressure is not provided for and apparently would have to be supplied by the patient's own muscular effort to keep his trunk from being pulled over toward the side of the fractured arm.

Minor modifications are made in the Thomas or Blake methods to fill the demands of upper, middle and lower third positions of fractures of the humerus, including provision for flexion of the elbow in low fractures. Suspension is also advocated for fractures of the forearm. If the wound precludes the application of adhesive to the arm, a glove is fastened to the hand with Heusner's glue and traction applied to it through strings tied to the end of each finger of the glove, which projects beyond the finger of the hand, to obtain the necessary extension, the arm being swung in a Thomas splint. Two methods, those of Blake and Gassette are described, but the counter extension in both these seems impractical. It is pictured as being obtained by pressure at or above the elbow, which would seem not only to interfere with circulation but to be conducive to ischemic paralysis.

In Chapter III the application of traction-suspension for fractures of the lower limbs is considered. In addition to the classical methods of extension, some inventions arising from the necessities of the war are described. Among these is a foot piece of Sinclair which is fastened by seven independent adhesive strips placed transversely across the sole, the ends not quite meeting on the dorsum of the foot. Through this piece, extension can be obtained in cases of fracture as low as the ankle. An apparatus after Chutro is described for extension in fractures of the femur by means of a flexible steel band passed through the heel in front of the Achilles tendon and above the os calcis. Several other methods for application of extension (eight in all); some of which are classical, are described.

A systematic description of metallic splints for support of leg and thigh fractures is given and includes those of Thomas, Blake, Keller and Lardennois, all of which work by counter pressure on the ischium, and those of Hodgen, Gassette and Leriche, which do not make pressure on the ischium.

Special consideration is given to fractures of the thigh and the methods for keeping the member in the desired position of flexion at knee and hip, abduction and external rotation. The Thomas splint with variations and additions to suit the case seems to be the favorite. The multiplicity of pulleys, ropes and weights as pictured in some cases seems rather complex and one is inclined to wonder whether the system could not be simplified. By the method of Sinclair the leg is secured to the Thomas splint by longitudinal adhesive strips tied to the lower end of the splint. The leg and splint are then suspended by counter weights and pulleys. The primary extension is then the weight of the patient's body and the counter extension is obtained by a rope extending from the lower end of the splint to the transverse bar of the Balkan frame. The authors consider this method "infinitely superior" to traction made directly on the lower part of the leg by weights, because the body weight is much more powerful and accomplishes reductions which can not be obtained by even thirty-five pounds of direct weight. Furthermore, in applying direct weight, so much of the force is absorbed in friction with the splint that only a part is transmitted to the bone fragment. If after forty-eight hours there is still some over-riding in cases treated by the Sinclair method, the foot of the bed is raised higher and one or two pillows are taken out from under the head of the patient. If there is backward displacement, the hammock supporting the thigh is tightened and if the proximal fragment is outside the distal, the abduction of the thigh is increased to bring the distal fragment into line with the proximal.

The methods of Blake and of Keller are briefly described and the classical Hodgen splint considered more in detail. Traction in the Hodgen method is obtained with the knee flexed on the splint, either by means of adhesive or glued straps attached to the thigh only, or by the Steinman nail through the femoral condyles.

An elaborate scheme for total suspension of a patient which seems to have originated with one of the authors is given in detail and illustrated by drawings, diagrams and photographs. A strong hammock passes around the back and a sling under the back of the neck. The pelvis rests in a saddle constructed of padded bent iron rods and the injured leg in a Thomas splint. The sound leg hangs in a sling. All these appliances are hung from the Balkan frames by ropes and pulleys with counter weights all hanging at the foot of the frame. The patient can be easily raised to any desired height out of the bed and remain suspended there by the counter weights, or he can raise himself by means of hand holds hanging down from the frame within convenient reach. This position facilitates the dressing of wounds anywhere on the posterior aspect of the body. Sinclair has devised a hammock of cords on a wooden frame which serves the same purpose as the total suspension apparatus described above for cases of high fractures of the femur.

For fractures of the upper third of the femur, the methods recommended to maintain the position of flexion, abduction and external rotation are those of the Thomas splint, the Hodgen splint and the hammock frame of Sinclair. For the middle third the splints of Thomas and Blake or Hodgen are advised, and for the lower third, either the Thomas or the Hodgen. The method devised by Depage of passing a loop of wire under the lower fragment to hold it up in line in low fractures of the femur, is described.

Fractures below the knee are suspended in a Thomas or Hodgen splint and traction obtained by bands from the leg to the lower end of the splint in the former and by weight in the latter case.

A short chapter is devoted to the suspension treatment of stumps. Bands are glued to the soft part of the stump four in number, upper, inner lower and outer, extending longitudinally and attached to an iron ring about a foot in diameter in a plane at right angles to the axis of the stump, about a foot from the end of the stump. Traction by weight and pulley is then applied to the iron ring thus obtaining equal tension on each band. This prevents the retraction of the soft parts from the bone of the stump.—*William Arthur Clark.*

Society Meeting.

To the Members of the American Orthopedic Association:

In addition to the two days, June 16th and 17th, on which it has been announced that the American Orthopedic Association will meet in Atlantic City with the Congress of American Physicians and Surgeons, there will also be a regular session of the Association on Saturday, June 14th.

On the evening of June 14th the annual dinner of the Association will be held.

Current Orthopaedic Literature

Numerals at head of each abstract are for use in connection with the official "Classification of Orthopædic Literature," published in the JOURNAL for January, 1917, reprints of which are obtainable from the JOURNAL office.

III. ORTHOPEDIC OPERATIVE, POST OPERATIVE, AND ADJUVANT TECHNIC.

III, 1.

SURGICAL TECHNIC IN ORTHOPEDIC SURGERY. By Walter H. Elmer. *Annals of Surgery,* December, 1918.

As all who devote much time to orthopedic surgery know, this branch requires a technic in the operating room which is second to none. Asepsis is of the highest and most vital importance. In his paper Dr. Elmer has gone over some methods for the maintenance of sterilization of the operating field in a very practical manner. His deductions and directions are brief and to the point and are easily understood.

Appended to the article is a set of directions for the preparation of the patient, the operating tables and the instruments. A list of instruments for several operations is attached. Both should be printed, framed, and hung up in the sterilizing rooms of hospitals as a practical help and guide in the anticipation of successful orthopedic surgery.—*Harold A. Pingree, Portland, Maine.*

III, 1.

A NEW PROCEDURE IN AMPUTATION OF THE LEG. Phocas. *Paris Médical,* Nov. 30, 1918, p. 435.

A very simple and reasonable suggestion is made for the facilitation of technic in amputating the leg below the knee,—so simple, in fact, that one wonders why it has not been thought of before. Instead of having an extra assistant hold the leg up in the air and the surgeon almost standing on his head to work on the posterior and most important flap, the patient is placed in the ventral position, thus allowing the leg to lie on the table with the muscular calf containing the vessels and nerves presenting itself where it can be worked upon with ease. Then to bring the anterior side into the field, all that is necessary is to flex the knee on the thigh, in which position the bone is sawed and the anterior flap shaped. The stump can then be laid back on the table and the plastic work done. The only objection which has been made is that of the difficulty and danger in administering the anesthetic in the ventral position. The author meets this objection with his experience that with ether given with the Ombredonne apparatus, the patient's head being turned on the side, the anesthesia is carried on as easily as in the dorsal position.

The author is undoubtedly original in this use of the ventral position, although it has been used from necessity rather than choice in bone graft operations on the spine in which the graft is taken from the tibial crest, the knee being flexed on the thigh for that purpose.—*William Arthur Clark, Chicago.*

III, 1, and III, 7.

IMMEDIATE APPLICATION OF APPARATUS IN CASES OF AMPUTATION OF THE LOWER LIMBS. Roederer. *Le Progrès Médical*, Dec. 7, 1918, p. 409.

The author deplores the fact that insufficient attention is given among French surgeons to the early use of apparatus on leg stumps, a subject which is considered of first importance among the Belgians, English and Americans, and mentions that at one of the nine centers for prosthesis of which he is chief not one amputation case had any provisional apparatus on arrival, in spite of the fact that some of them had been three or four months under treatment. Several good reasons are given for early prosthesis. A stump which is not used undergoes muscular atrophy and becomes fatty. The position which a stump naturally assumes as a result of muscle tension is usually unfavorable for prosthesis, and should be prevented. By early use of the weight-bearing surface the stump will be ready for permanent prosthesis two or three months sooner than otherwise. The patient himself is given early hope and his convalescence is hastened by starting him at once on some sort of an artificial limb. The surgeon who does the amputation should, for his own edification, see an early trial of the stump which he has fashioned and should realize that his work is not ended as soon as the knife is laid away. Immediately prosthesis is part of the therapeusis.

What is said here of the French may be applied also to the Americans, judging from the number of flabby stumps that finally come to the general hospitals. It is within the knowledge of the abstractor that the French were the first to recognize, early in the war, the necessity of early prosthesis with provisional apparatus, and that the Belgians began to take up the work in the early part of 1916.—*William Arthur Clark, Chicago.*

III, 2, *b*.

ORTHOPÆDIC RECONSTRUCTION WORK ON HAND AND FOREARM. A Steindler. *New York Medical Journal*, December 28, 1918.

Steindler's paper embraces a study of sixty cases, and it is impossible to adequately synopsize such an article, but probably the chief point of interest is his dealing with the cases where a transference of the flexor carpi ulnaris and radialis is done for loss of power in the extensor muscles. Before this is undertaken, he thinks there should always be an arthrodesis of the wrist done so it is stabilized in a favorable position, which is that of moderate extension. He then takes the flexor carpi ulnaris and radialis and brings them through the dorsal surface through an opening in the interosseus membrane just above the pronator quadratus. He then fastens them by side to side apposition to the extensor tendons of the fingers, and says that in a very few days after the operation active extension of the fingers can be noticed, but advised keeping the hands completely immobilized four to six weeks and later carefully supported by a splint to be removed only for massage and exercises.

His results following this operation have been satisfactory, and the result in the one case of interosseous tendon transplantation without previous arthrodesis showed only fair correction and function.

In two cases of flexor paralysis of the wrist he swung the extensor carpi ulnaris and extensor pollicis longus around the radius and ulna and fastened them to the flexor digitorum communis. The functional result, however, was only moderate in these cases.

The article is one which does not permit readily of abstracting and should be read by those interested, there being much excellent material in it.—*M. S. Henderson, Rochester, Minn.*

III, 7.

Reconstructive Surgery. The Problem of Records. J. Appleton Nutter, M.D. *The Journal of the American Medical Association,* Feb. 8, 1919.

Dr. Nutter's brief description of the charts used at Hart House, Toronto, for the purpose of recording limits of motion serves to illustrate the fact that pictures, rather than descriptions often best indicate conditions.

Diagrams are used in the records of the Canadian Army Medical Service, and consist of a series of straight lines which represent the bones. These touch at certain points to make the joints and lie at certain angles to represent the extent of motion. The article is illustrated with four line drawings.—*Harold A. Pingree, Portland, Maine.*

XVIII, 8.

New Operation for Hallux Valgus. J. Torrance Rugh. *Medical Record.* Nov. 9, 1918.

This condition is divided into two classes of cases—(a) in which the osseous hypertrophy is not excessive, and the angle of deviation of the great toe is not over 30°. Removal of the exostosis is sufficient to cure this class. (b) in which the angle of deviation is more than 30°. The hypertrophy is removed and a cuneiform osteotomy back of the great toe joint is made. In lieu of this procedure the author makes a curved longitudinal incision with the base down over the joint. This flap is turned down. Then he makes a tongue shaped flap with the base backward similar to the Mayo flap. This includes the bursa and the internal portion of the capsular ligament. Sufficient of the epiphysis of the metatarsal bone is removed by diagonal cuts from within outward and from behind forward. The inner sharpened corner is removed, and the second flap is secured across the ends of the bones. Ankylosis is prevented and the deformity is corrected. Excellent results have been attained in twelve cases. The article is illustrated with drawings.—*Edward Z. Holt, Atlantic City.*

XIX. TRAUMATIC CONDITIONS.

XIX, 1.

Investigation of 1000 Consecutive Cases of Peripheral Nerve Injuries. J. L. Burrow and H. S. Carter. *British Medical Journal.* November 16, 1918.

This remarkable number of cases was carefully observed and systematically charted. Accurate notes were taken in regard to condition of the skin, joints and muscles of the limb involved, as well as to the local condition of the nerve and paralyzed muscles. Sensory examinations were taken in regard to touch, thermal sensibility, deep sensibility, discriminating sensibility and the electrical reaction was also ascertained, interrupted as well as constant current.

Musculo-spiral nerve found injured in 204 cases, median nerve injured in 242 cases, ulnar nerve injured in 327 cases, sciatic nerve injured in 121 cases.

In connection the author points out the following facts: Trophic and vaso-motor functions are the first to recover. The next to recover are the deep sensory functions, first in regard to pressure and sense of motion in

the joint, and last the discriminating sensation. Voluntary movement appears in highest centers of the muscles and gradually extends downward.

The first change after nerve suture is brisk response to anodal closing stimulus. The faradic responses are usually much slower in re-appearing. Occasionally faradic responses return soon after voluntary movement.—*A. Steindler, Iowa City, Ia.*

XIX, 1.

On Injuries of the Cervical Spine. Joseph Ransohoff. *Surg., Gynec. and Obstet.* September, 1918.

The author "talks" about 14 cases of cervical spine injury, with six deaths In a very "readable" article, he takes up the case histories, neurological and x-ray findings and the treatment of the above cases. The results obtained seem to show that his conservative plan of treatment was well founded. It is well illustrated, but does not lend itself to abstracting.—*Leo C. Donnelly Detroit.*

XIX, 1.

Mechanical Treatment of Peripheral Nerve Injuries. By Byron Stookey. *Surg., Genec. and Obstet.* Nov. 1918.

The first cardinal principal of mechanical treatment of peripheral nerve injuries is to obtain relaxation and prevent over stretching of the paralyzed muscles. There are two main types of apparatus: those which aim to prevent over stretching and correct faulty position, and those which attempt to replace a part of the movement lost. An appliance is to be preferred which attempts to correct the total deformity and to prevent over stretching. Each appliance is made for individual cases, modifications when expedient, altered and changed according to progress. Apparatus should be light, simple, easily applied and removed, immobilized no more than is necessary, should be cheap and inconspicuous. Should treat the total deformity, not merely one of the apparent faulty postures. The straps should fall on tendons rather than constrict muscle bellies. Avoid producing pressure sores. Splints removed at night should be replaced by more comfortable and equally efficient retentive apparatus.

Early mechanical treatment. The severed nerve tends to assume a definite position and to keep it, being held more or less firmly in place by the fascial layers which so intimately surround the nerve trunk. The position to be maintained will depend upon the level of the lesion in the nerve. In injuries to the median and musculo-spiral in the upper arm, the arm should be adducted and the forearm acutely flexed; in injuries of the ulnar, the arm is adducted and the forearm held extended; in injuries below the elbow to the median, the forearm is flexed at a right angle and hand placed in full supination, and the same position for the musculo-spiral, except that the hand is held dorsi-flexed; in ulnar injuries at the same level the forearm is fully extended and the hand flexed in slight adduction. The sciatic is relaxed by knee flexion. Where there are other injuries such as fracture, which might lead to more or less permanent deformities, the primary indication is to treat the fracture.

Correction of deformity before operation: Prior to operative interference in nerve injuries all contractures must be overcome and free mobility of joints assured. Contractures and adhesions should be stretched gradually and continuously, as daily movements when of sufficient force to increase mobility constantly tear the fibrous tissue, which in turn sets up new

fibroblastic reaction. Gradual overstretching gives less reaction and is more permanent.

In brachial plexus injuries to the 5th and 6th cervical nerves the arm must be abducted to relax the deltoid and supraspinatus; and in external rotation. Abducted to 60 degrees and held in the mid coronal plane, the arm overcorrected in external rotation and the forearm flexed on the arm, and held in slight supination so that the hand faces the mouth. A splint is described to maintain this position.

In injuries involving the last cervical and first dorsal nerves a straight splint in line with the forearm, with individual grooves for each finger, with the fingers in slight abduction, offers the most satisfactory mechanical treatment. In seventh cervical and musculo-spiral paralysis mechanical treatment aims to relax the deltoid and overcome the results of gravity on the extensors. In musculocutaneous paralysis there is very little mechanically indicated; holding the forearm flexed and the hand supinated prevents over-stretching, which also is guarded against by the engagement of the olecranon against the humerus. Ulnar nerve. The clinical manifestations are extremely variable, due to the large number of muscles supplied, and their rather antagonistic action, and to the variability of supply. Efficient immobilization must be combined with efficient mobilization. All movements should be regularly performed and the periods of repose guarded by suitable apparatus. For a complete lesion a simple palmar splint with individual gutters for each finger will usually suffice. In median nerve paralysis a straight splint with slight flexion for the distal phalanx, with separate grooves for each finger will suffice. In anterior crural paralysis a Thomas walking caliper splint is applied allowing of 30 degrees flexion and prohibiting hyperextension. In total sciatic paralysis there is complete flaccidity below the knee, for which a modified Thomas splint is applied, permitting knee flexion to 45 degrees, fixed to a sole plate maintaining foot in dorsal flexion. Inner side of heel and sole is raised to prevent valgus deformity.

In paralysis of the external popliteal the deformity to be prevented is one of pes equino varus. An inside iron attached to the shoe preventing plantar flexion, combined with raising of outer portion of heel and sole, correct the deformity. Internal popliteal paralysis generally produces pes calcaneo valgus. An outside iron with stop lock prevents dorsal flexion. An arch support holds up the arch. Raising the inner side of heel and sole aids in preventing valgus. For flat foot following paralysis a properly made steel arch is supplied.

Electricity, massage, and baths are taken up in their application to nerve injuries. This article is long, well illustrated, and goes into details of diagnosis and in a way is a résumé of experimental nerve surgery done at the University of Michigan. It should be studied, not read.—*Leo C. Donnelly, Detroit.*

XIX, 2, *a*.

Fracture of the Neck of the Femur. James Warren Sever. *Boston Med. and Surg. Jour.*, Jan. 9, 1919.

This is a careful report of the end results of 40 cases of fracture of the neck of the femur in men and women of all ages. There are 21 cases of the intertrochanteric type and the others represent the sub-capital type of fracture. The good results represent only 23% of the cases with known results.

The author advocates the Whitman method of treatment by means of

forced abduction, and questions the necessity or advisability of the forcible impaction method as used by Cotton.

The paper is illustrated with numerous line drawings and will well repay the study of those who are called upon to treat this type of case.

XIX, 2, *a*.

THE ABDUCTION TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR. A Comparative analysis from the standpoint of technical efficiency. Royal Whitman. *Surg., Gynec., and Obstet.*, Dec. 1918.

In an article well illustrated the author advances his method of treating fractures of the neck of the femur. The anesthetised patient, clothed in fitted shirting or a combination suit, is lifted to a pelvic rest screwed to the end of the table and provided with a perineal bar for counter traction, the shoulders resting on a box of equal height. The limbs extended, and side by side are each supported by an assistant. Direct manual traction is then made by the assistants against the resistance of the perineal bar, while the surgeon, standing on the injured side, lifts the thigh upward, guiding the trochanter to its normal position. When the shortening has been reduced as demonstrated by comparative measurements, the limb, which is usually rotated outward, is turned until the patella turns slightly inward. The two assistants, still exerting equal traction on the limbs, abduct them, that on the sound side slightly in advance, in order to demonstrate the normal range and to benefit its fellow, so that the tension on the capsule as the fracture is adjusted may not tilt the pelvis upward. A final inspection shows the extended limbs equally abducted on a level pelvis with all the landmarks corresponding, complete abduction, complete extension, slight internal rotation. Plaster cast extends from nipples to the toes of the injured limb; on well side so cut as to allow complete flexion. The support assures anatomical rather than direct splinting. The long spica is most effective because the leverage above and below the joint is about equal. The limb is hyperextended in order that the strong anterior wall of the capsule may be made tense and because support in this position checks any tendency toward backward displacement of the outer fragment to which the force of gravity predisposes. Slight flexion of the knee lessens the strain on the joint, and inward rotation follows the principle of over correction of preëxisting deformity. The head of the bed is raised a foot or more by blocks, the patient turned at intervals to avoid hypostatic congestion.

The plaster spica is retained as a support from eight to twelve weeks to assure adhesion of the fragments, but by no means a resistant union. After its removal the patient remains in bed for several weeks for massage, passive and active movements of the joints and reëstablishment of the muscular control. Several times a day the limb is drawn out by the attendant to the full limit of abduction, otherwise a gradual restriction of its range will be apparent. Weight bearing should never be permitted, with the possible exception of certain fractures at the base of the neck, or in childhood, for at least six months, and often only after a much longer interval, because the repair is slow and the strain is great. The indications for the resumption of functional use are the situation of the fracture, the process of repair as shown by the x-ray, by the restoration of voluntary control and the freedom from discomfort on passive movements. The use of a caliper hip splint which permits of locomotion without direct weight bearing is desirable; otherwise crutches are necessary.—*Leo C. Donnelly, Detroit.*

Vol. I, No. 5 MAY, 1919 Old Series: Vol. xvii, No. 5

The Journal of Orthopædic Surgery

SOME INTERESTING BACK CASES.

BY LORING T. SWAIM, M.D., BOSTON.

THE assertion that the sacro iliac joint can be subluxated or that it can be displaced and produce sciatica has provoked much discussion.

In offering the histories of these cases I hope that some light may be shed upon this difficult problem.

The sacro iliac joints are admitted to be true movable joints with articular cartilage and capsule. They are held in place by excessively strong bands of heavy ligaments, reinforced by muscles. The sacrum, bearing the downward thrust of the body's weight upon the pelvis, is a rather weak articulation. Because of this downward pressure the inclination of the pelvis is of great importance in relation to strain of the sacro iliac joints, because if the pelvis is tilted forward the sacrum becomes more horizontal, and more weight falls on the ligaments; if the pelvis is upright most of the pressure is exerted upon the sacrum, wedging it into the grip of the ilia and exerting less pull on the ligaments.

Much misunderstanding exists as to the displacements of these joints. The displacements, when they do occur, seem to be mere rotations, a forward or backward rotation of one side of the sacrum on its iliac articulation. That these rotations are too slight to detect by x-ray is logical, because we have to rely on the stereoscopic vision to detect the minute variations.

Scientifically I feel that such a rotation cannot at present be definitely proved, but clinically it does take place in some few cases, we seem forced to believe.

The sciatica is due to pressure on the sciatic nerve, which crosses

directly over the middle of the saero iliac joint, lying upon the ligaments as close to the joint as it ean well rest. This pressure may be due to fluid in the joint, inflammation in the joint, swollen ligament, or inflammation in the region of the nerve from any abnormal condition of the joint.

In each ease the manipulation was the same, consisting of raising the leg, with the knee straight, on the side where the rotation seemed to have occurred, to a perpendicular position or further, the opposite leg being held down by an assistant. The same proceedure was followed with the other leg, and then the patient was turned on the face and the leg was hyperextended backward, pressure being brought to bear with the hand over the saerum. The proeedure was reversed in this position, raising the leg on the other side from the apparent rotation first, and after sufficient manipulation the back was strapped with adhesive and the patient was left lying on the back, with a small pillow filling in the hollow of the lumbar spine, a large pillow plaeed under the knees.

The following eases seem to suggest actual displacements:

Mr. M. was a farmer, 30 years old, weighing 250 pounds. He had always worked hard and was noted for his muscular strength. One day, while lifting a sugar barrel, he suddenly felt a sharp pain in his low back, which "doubled him up." After a week's rest he was praetically well except for a feeling of weakness in his leg and saeral region. Three months later, while splitting wood, the acute pain returned, localized in the left sacro iliac joint and extending down the left leg along the seiatic nerve to the foot. He was in bed this time for three months, during which time he could not straighten his left leg or rest on his back. When first seen, three months after this seeond mishap, he was suffering such pain that he was short of breath. All motion produced pain, which was referred definitely to the left saero iliac joint. This joint was very tender to touch, and leg raising was impossible beeanse of pain. X-rays showed no definite evidence of displacement. The left hip was normal. The only evidenee of rotary displaeement was the increased prominence of the left posterior superior spine of the ilium, as compared to the right, with a deeper sulcus between it and the saerum. There was no demonstrable evidence of infection anywhere, and no tumors to be felt by rectum. Manipulation was advised. Since the patient was in such pain, he was given a large dose of asperin and morphia for the night and placed on his back with a pillow under the small of the back and two more under the knees. He slept heavily. In the morning, when preparation was made for manipulation, it was observed that all the pain had ceased. Leg raising was possible with limitations. The posterior iliac spines seemed equally prominent and the legs were equal in length. Manipulation

was given up. A double plaster spica, extending from the armpits to the knees was applied at once, and left on for three weeks. After this a light brace was fitted, and from that night to the patient's discharge, in four weeks, there was no recurrence of pain. A year later, while lifting the back of a carriage the pain returned, this time there being no outward change in the sacro iliac joints. Renewed support, after rest, gave entire relief.

In this case it seems probable that the sacrum had rotated forward from the ilium on the left, bringing pressure on the nerve. Complete relaxation caused the slight readjustment to take place with almost immediate cessation of all symptoms.

Mr. H., a coal dealer, forty years old, a moderately heavy man of powerful build, who "strained" his back shovelling coal. He had several manipulations. After the last one he was unable to stand for three days because of the pain in the right low back and down the sciatic nerve on the right. The physical examination was negative for infection or organic disease. The x-ray showed large transverse processes on the fifth lumbar vertebra and the pelvis inclined downward so as to make a true articulation between the fifth transverse process and the wings of the ilia. There was no evidence of disease or displacement of the sacro iliac joint seen in the plates. Locally there was tenderness over the posterior superior spine of the ilium on the right, which seemed more prominent than the left. Leg raising on the right was 40°, as compared with 90° on the left. The sciatic nerve was not tender. The right leg was shorter than the left. A support was tried for several weeks without relief. Then, under anesthetic, he was manipulated without definite sense of slipping of any displacement. He was better at once. The pain decreased, his legs were equal in length, and only after standing for some time did the sciatic pain recur. Everything went well until he had acute tonsillitis, after which the back again became tender and he had more pain in his right leg. This gradually diminished and he has steadily improved. Five years have gone by with no recurrence of symptoms, even with hard physical work.

I believe this was a strained joint, rotated slightly by manipulation, and replaced later. Some infection settled in the injured, inflamed joint, which subsequently cleared up.

Mrs. H. was a woman of 43, much under weight and lacking in muscular strength. The chief complaint was left sciatic pain from hip to toes and pain in the left sacro iliac joint. The history showed overwork for a winter, with much loss of strength, footache for a month, and finally backache for one day. The next morning, as she tried to close a window, there was a sudden severe pain running from the left hip along the sciatic nerve to the left toe. She collapsed and was unable to get out of bed for ten days. The pain required morphia. When seen, she lay with the left hip flexed, and any movement caused pain. The examination revealed some bad teeth with pyorrhea, no tumors, and the pelvic region was negative except for pain over the

sacro iliac joint on the left. Locally, there was a spot inside the left superior posterior spine of the ilium which was tender on deep pressure. There was a half-inch atrophy of the left leg muscles, and the buttock also was flaccid. Leg raising on the left was limited to 20°, and produced much pain in the back. The x-ray showed a blurring of the left sacro iliac joint, although no definite evidence of displacement. The back was manipulated. There was a sharp click on lifting the left leg with the knee stiff. This could be felt and heard. The back was strapped, and after the anesthetic wore away there was no pain except at the knee and a little in the back. Better tone of the left leg muscles was noted in nine days, and in a month the leg was strong enough to use, and she was able to be about, with a support. The atrophy had practically gone. In three months the legs were alike, and she had gained 20 pounds. A year later, after overdoing hanging curtains, etc., pain returned in the sacro iliac joint. Examination again showed tenderness over the right joint, with slight limitation of leg raising which caused pain in the back. Heat and rest with support gave relief, and for six years she has stayed well, except when tired or unsupported. The rapidity of the relief in this case was astonishing.

Judge C., a man of 64, while on a vacation had a fall, landing on the right ischium, which caused him such acute pain that he felt "stunned." Ten days later the pain had gone. Three weeks later, while rowing a low-seated boat, he had "a feeling as if something cracked," with a sharp pain in his lower back. He could hardly move He had manipulative treatment for a while, which relieved him somewhat, but the pain recurred intermittently and he became stiff. After six months of this, he found one day that it was impossible to get about. When seen, seven months after the onset, he was normal physically; locally, he had a flat back, with slight tenderness over the sacral region. There was a marked hamstring spasm of the left leg, and all motions were limited. During the examination there was a slight click heard while lifting the left leg, with pain following. The back was strapped, and, much to Judge C.'s joy and my surprise, the next day he had no pain. Soreness in the calf of the leg and a dull ache in the right sacro iliac region disappeared in about a month. The x-ray showed only an increased density between the fourth and fifth lumbar vertebrae, with what appeared to be a chip off the lower portion of the body at the fourth vertebra on the right side. The sacro iliac joints were apparently normal. This was taken after the lucky accident. What happened, I do not know, but something that had been abnormal became suddenly normal and relieved irritation of the sciatic nerve.

Mr. B. was a strong, healthy man of 43 (seen in consultation after a week's rest in bed). The history is that in December, 1913, he fell, causing unpleasant sensations in the region of the right iliac fossa. He had some pain down the back of both legs. He became very nervous and depressed. Examination showed him to be quite tender over both sacro iliac joints. Leg raising was limited on both sides. He

admitted having an ache in the small of his back, and quick motion caused pain. His legs were equal in length. He spoke of a "lumbago" two years before. X-rays showed a lumbo sacral articulation of the fifth transverse process, and the left ilium was somewhat higher than the right in relation to the sacrum. A week's rest in bed caused entire cessation of pain in the back. There was no manipulation, although this was advised at the consultation. The subsequent history is that some weeks after leaving the hospital, while climbing a fence, he felt a distinct click in his back, localized at the left sacro iliac region, which immediately relieved him of all pain. This was over a year ago and he has had no recurrence of the trouble.

Dr. V., 54, was seen in consultation for sciatica of six weeks' duration. For a year he had been troubled with a mild aching in the lumbar region after standing. Usually this was relieved by extending the right leg behind him. Six months later he had an acute attack of "lumbago," and went to bed for a week, during which time his back began to get stiff. He tried to work for a month, then went for a trip to rest. The back and leg, however, continued to ache. This soon became pain, with numbness in the right leg, and he was lame. Osteopathy was tried without relief. The pain became so bad he had to come home, with a constant agonizing sciatica, requiring morphia. The only relief he had was by hyperextending the right leg backward, resting the hands on the floor. When seen six weeks later, he was listed to the side when standing and could not lie on his back because of the pain in his back and right leg. Tenderness over the right sacro iliac joint was marked. The posterior superior spine of the right ilium was tender and prominent. Leg raising was 30° on the left and none on the right. The length of the legs was equal. The right sciatic nerve was tender in its whole course, the right buttock was flabby and all the muscles of the leg were atrophied and flaccid. X-rays failed to show any lateral displacement of either articulation and appeared normal. There was a slight lumbar lateral curve to the left. Manipulation was done under ether, and a distinct slip was not only felt but heard while hyperextending the right leg backward, and the prominent posterior spine of the ilium on the right was more like the left than before manipulation. The back was strapped with adhesive. The next day there was no pain at all, only lameness. In a week he was up, with a support, and no return of pain in the leg or back, and the tone of the right leg muscles had increased noticeably. Five days more and he walked without pain. There was occasional pain at night when in bed. This was relieved by adhesive strapping. During the next month he had a little pain in the leg, at times up at 4 a.m. The lateral list and the tenderness of the back disappeared. The examination showed no difference in the two sides of the sacro iliac joint. The atrophy of the muscles continued, but the tone was good. The nerve tenderness had gone. The support was continued. Six months later the pain was all gone; he was working and the atrophy had almost disappeared. In a year all signs and symptoms had disappeared and he walked and acted perfectly normal. Exercises were given to strengthen the whole

muscular system and the support was to be gradually discarded. From 1914 to the present day he has had no recurrence.

It is hard to explain, with our limited powers of touch and the apparent inability to get definite enough evidence from plates of this region, just what took place in these cases. That some very small misplacement was present seems probable. I am forced, by the results and from the consideration of the referred nerve pain, to think it true that it was close to the sciatic nerve, and in one or two cases the trouble was severe enough to cause atrophy of the muscles supplied. The extraordinary rapidity of the relief and the apparent slip to be felt in most cases is significant that something went into place to cause relief.

Nerve stretching of the sciatic nerve will not relieve backache in my experience.

I admit I do not know what happened to most of the cases, but the last case was so pronounced, the change in the relation of the iliac spines in a thin man was so noticeable after the slip, and the relief was so complete, that I feel sure this, at least, was a sacro iliac rotation on the right joint.

The members of the American Orthopedic Association will be grieved to learn of the sudden death of Dr. H. Augustus Wilson of Philadelphia, on April 16, 1919. A further notice of Dr. Wilson's life will appear in a later number of this JOURNAL.

Correspondence

Washington, March 20, 1919.

To the Editor:—

As stated in the circular memoranda for editors of medical publications issued by the Surgeon-General's Office, on March 27 and May 22, 1918, it is required by paragraph 423, Manual of the Medical Department, that all medical manuscripts by medical officers, U. S. Army, intended for publication, shall be first submitted to the Surgeon-General's Office, Washington, D. C., for approval. This regulation, which has been very courteously complied with to date, is still in force so far as medical officers on active duty are concerned. In the case of medical officers recently retired from active duty, it is requested, as a courtesy to the Surgeon-General and in aid of assembling material for the medical history of the war, that all medical manuscripts based upon military or official records or upon military experience during the war, be submitted, as heretofore, to the Secretary, Board of Publications, Surgeon-General's Office, Washington, D. C., for record and approval, and that such MSS. be accompanied by a carbon copy. Upon approval, the original copy will be forwarded to the journal designated, for publication, and the carbon will be filed in the records of the Medical History of the War.

For the Surgeon-General:
(Signed) C. R. DARNALL, *Colonel, Medical Corps, U. S. A.*,
Executive Officer.

RECONSTRUCTION HOSPITAL ON PARKER HILL.

BY MAJOR FREDERIC J. COTTON, M.C., U.S.A., BOSTON, MASS.

On receipt of the editor's suggestion that something might be written about the opening up of the U. S. A. General Hospital No. 10, Parker Hill, Boston, the first thought was to reply that there was nothing to write, as we have not yet accomplished anything. And that of course is true, for our patients are few and recent, and end-results—the only important item—are not yet at hand.

Yet the preparation is in a way an accomplishment, and at least the opening has been so auspicious, the hospital plant so well conceived and wrought, so well equipped as to deserve brief notice, and the plans for coördinated work seem, perhaps, more than usually comprehensive, perhaps because they have been so long in maturing.

For there is a bit of story connected with this particular institution, worth telling because it is wrapped up with the development of the reconstruction idea which has come to be so characteristic of our whole conception of military medical service in this war,—peculiarly worth telling in this Journal because the reconstruction idea, now general, was, in its infancy, an orthopædic conception.

It was in a preparedness committee of the American Orthopedic Association that the reconstruction idea had its birth, so far as this country is concerned, and there is nothing here or planned for the work of this hospital that was not included in the scheme laid down by Colonel Goldthwait, Colonel Brackett, and the writer, a year and a half ago.

The hospital was planned partly to be a concrete expression of the reconstruction plan. This plan,—a scheme for really coördinated care of returning wounded, running from surgery through physiotherapy, bedside occupation, and shopwork to real vocational work,—was promptly adopted by the Surgeon-General, but at the time no Government funds were available for construction of such hospitals.

Then it was suggested to the great Benevolent Order of Elks that such construction might well be a part use of their war fund.

Their war commission, patriotic and far seeing, looked into the matter,—thought well of it.

So, a year ago, the commission went to Washington and, through their spokesman, ex-Governor John K. Tener, offered such a hospital to Surgeon-General Gorgas, who accepted for the Government.

The Elks' Reconstruction Hospital has been built and is the central

and important member of No. 10. Built on the top of Parker Hill, on the site of the old Reservoir, filled in the summer of 1917 by Mayor Curley to provide a site. This hospital represents an expenditure by the Order of about $300,000.

The plans, partly drawn in the Surgeon-General's office, partly by Lewis F. Day, and by Desmond and Lord for the Elks, were carefully studied and seem to have been wisely ordered. The Elks' Hospital is purely a treatment hospital building, furnished with heat and light and operating facilities by the adjoining Robert B. Brigham Hospital, through tunnel connections.

The Elks' Hospital has, therefore, in relatively small space, accommodation for over three hundred patients, a fully equipped building for electrotherapy, hydrotherapy, and mechano-therapeutic work, a shop building 150 feet by 22 for curative work and for the surgical appliance shop, and a barracks building. The whole block of building is 300 by 150 feet, with 45,000 feet of floor space.

The equipment, of course, is army equipment, save for the excellent outfitting of the shops, which the Red Cross did, and for the furnishing of a ward by the people of the town of Belmont.

After the erection of the Elks' Hospital it became evident that the need was greater than had been foreseen. It was too small.

Then the trustees of the Robert B. Brigham Hospital, with the finest spirit of service, entered into an agreement with the Government by which they turned over their hospital for war use, taking care of the patients of their charity elsewhere.

At the same time Mayor Peters, for the City of Boston, offered the West Department of the City Hospital in West Roxbury, for the use of the Government during the war period.

This is an elaborately modernized hospital plant of two hundred and fifty beds, fully equipped, prepared by the City for a contagious hospital, but not yet used. It is six miles away from Parker Hill, but so well equipped as to be suitable for a half independent unit. It was accepted and is in use.

Beside all this, the Massachusetts Women's Hospital (the old Charity Club) was offered and was leased for nurses' quarters.

U. S. A. General Hospital No. 10 consists, then, of four hospitals,—the Elks', built for the Government and turned over; the Brigham, leased; the West Roxbury plant at a dollar a year; the Massachusetts Women's, leased.

This, when you come to think of it, is not a bad community showing,

more particularly if one considers the very wonderful spirit of service in which the representatives of these institutions coöperated with us in every way.

Colonel Joseph Taylor Clarke was assigned to the command and has under him these four properties, now in commission and actual use.

It is too soon to say much as to the work. One may say, however that the personnel is on hand, large, and very competently trained for all branches.

It looks as if the work were to be predominantly orthopædic in the larger military sense, and preparation has been made for such surgery as this calls for, not always showy, but calling for high grade work of specially trained men and for the very best operating conditions.

Provision is at hand for the carrying out of first rate shop work, including the making and fitting of artificial limbs.

The physiotherapy department is the part of this hospital that should be strongest. It looks strong and the plans are laid for a great deal of work by the doctors and the excellent staff of trained women aides.

Rather unusually extensive use of electrical treatment is contemplated, and of hydrotherapy.

The educational department amply staffed from Washington, bids fair to be very busy,—is already busy.

The plan of work is in no large essential different from what is projected elsewhere,—what has been done to some extent at the Walter Reed Hospital in Washington and three or four other places.

This is just a story of the origin and completion of a special hospital which we hope may prove of special value for the returning men for whom the best we can do is none too good.

Beyond this, we have high hopes of being able to help in standardizing methods to aid in the cure of military orthopædic cases in a way that may help solve the like problem in peace.

In the past, our civil work of this sort has been poor, not so much because we did not know as because we were not in shape to coördinate our special workers and special means of cure.

Here, today, we have an institution, particularly favoring the working out of such coördination.

With hard work and the mutual coöperation we hope for and expect, something should be accomplished to give us a broader grasp of the general problem of reconstruction, civil as well as military, and show us the lines of organization and coöperation along which we must move to achieve results in this line of scientific (and economic) endeavor.

DIAGNOSIS OF SYPHILIS OF BONES AND JOINTS.

BY JAMES O. WALLACE, M.D., PITTSBURGH, PA.

In observing cases of bone and joint syphilis for the last five or six years, I have been impressed by the number of mistakes made in the diagnosis of these conditions. Time and time again cases have presented themselves in which operations for osteomyelitis have been done. Joints have been opened and the cases have not done well.

The interpretation of roentgenograms has been a very difficult subject to many men.

In reading textbooks on syphilis of bones and joints one finds the subject almost passed over, or at most, little information is given. In view of this fact, students have little access to printed material which will give them any adequate idea for their instruction. There have been numerous articles in the literature treating upon the subject, but in the main these are only reports of cases. No article that I have found has been presented giving the differential diagnosis from the x-ray and laboratory findings as well as the clinical, physical and history findings, hence, it is my purpose in this paper to present the differential points in the diagnosis of syphilis of bone and joint conditions, setting forth in as clear and simple a manner as possible, the findings that are known up to the present time

It is not within the scope of this paper to discuss the various classifications of bone and joint syphilis.

Bone and joint syphilis has been divided into two general heads—congenital and acquired.

Parrott gives the following classification in congenital bone syphilis·

1. Atrophic (osteochondritis).
2. Osteophitic.
   a. Osteoid (all ages) resembles secondary lesions in adults.
   b. Rachitic (only after 5 or 6 months) is a localized or gummatous formation resembling the tertiary found in adults.

Bingold gives the following classification in acquired syphilis:

1. Osteoperiostitis.
   a. Diffuse or neoplastic.
   b. Circumscribed or hypertrophic.

In the classifications of joint syphilis De Fontaine presents the following:

1. Arthralgia.
2. Subacute arthritis.

3. Hydrarthrosis.
4. Perisynovial gummatous conditions.
5. Association joints with bony syphilis.

O'Reilly also gives a classification in acquired and congenital joint syphilis:

1 Acquired.
   a. Early secondary (arthralgia-multiple).
   b. Secondary (synovitis with hydrops).
   c. Tertiary (gummatous osteitis).
2. Congenital.

Same types as acquired but one form seems to merge into others. This agrees with findings of Parrott, Hutchin, Morgan and Eve.

Wysochi says no definite classification of joint syphilis is possible

In our cases we have been unable to make any definite classification. Every case of joint involvement has been secondary to an osseous lesion.

In all suspected cases of syphilis of bones and joint diseases it is essential that we go into the family and personal history of the patient in minute detail, bringing out a complete history of the parents as chronic rheumatism, various eye troubles, chronic bone suppurations, miscarriages, sterility, etc., as well as definite history of the primary infection in either parent. In the personal history of the patient in congenital syphilis, one should look for such symptoms as rhinitis, lesions of the skin and mucous membranes, iritis, suppurating lesions of hands or feet and malnutrition.

In acquired syphilis it is not always possible to obtain a definite history, although in negative cases one should not be misled, for upon further questioning the patient in regard to the characteristic initial lesion or secondary manifestation, a history of syphilis may be obtained. There are cases, however, in which it is impossible to obtain a positive history, yet, upon inquiry, the patient may state that she has had chronic rheumatism or miscarriages or history of sterility which would excite suspicion. In a negative history one must not overlook the fact that in any suspected case a Wassermann should be made.

Symptoms. Onset is generally insidious with frequent relapses. Occasionally it begins immediately after weaning. In about 15% of our cases it followed a definite history of trauma and the fact that cases generally occur in bones or joints most exposed to trauma, would lead one to assume that trauma was an important factor. The absence of definite history of trauma is probably due to the fact that it is overlooked by the patient.

Pain. Pain was the general symptom in our series of cases. In 56% of the cases of acquired syphilis osteocopic pain was present in a very severe form; in 19% of the congenital cases it was present, but not very severe, and in our remaining congenital cases there was no osteocopic pain present, although there was extensive involvement of the bone. Pain was present in every case except one, but it was insignificant in proportion to the pathology present. This agrees with the findings of most authors. We found that movements of the involved joints increased the pain, except in one instance. This is not in accord with findings of many writers.

Swelling. Swelling was present in 50% of our cases.

Physical examination. In 70% of our cases tenderness was elicited, and of the 10 cases not showing tenderness, five were cases of spinal syphilis or Charcot spine. Redness and local increase of temperature were present in but ten of our cases. Swelling was present in 55% of our cases, excluding the cases of spondylitis. In taking into consideration the actual swelling of the joints, all the cases show that bony parts also were swollen. This is in accordance with the observation made by other authors, and we consider it a diagnostic sign. Fluctuation was comparatively a rare sign, we finding it present in only 9% of our cases. In 27 cases in which there were joint symptoms, 50% had limitation of motion. This is not in accordance with the reports given by the majority of authors. In our cases of spondylitis four were tubercular, complicated with syphilis, or purely syphilitic.

One case showed a characteristic kyphosis with no other local physical signs, although the roentgenogram showed destruction of two dorsal vertebrae. In another case with no deformity, showing no local physical signs, evidence of bone destruction with new deposits of bone was seen in the roentgenogram. (See case No. XIII.)

Sloan says syphilis of the spine may occur at any age from infancy to late life but that it is most prevalent about the fourth decade. In differentiating it from tuberculosis one must be guided by history, laboratory findings and other syphilitic markings noted in the physical examination.

Whitney and Baldwin bring out a new sign in the diagnosis of syphilis of the spine. In examining the spines of 100 known syphilities they found a localized area of limitation of motion with a hypotonia of the remaining portion of the spine in about 68 cases. They considered this limitation of motion was due to the perisynovitis of the limited portion of the spine with adhesions. If the process involved intervertebral joints the patient had a resultant flexion of the spine, and resultant

extension of the spine if the laminae were involved. This sign was always developed in old patients, where every other evidence of the disease may be lacking

Laboratory Findings. In our series of 38 cases we have 24 cases with a positive Wassermann test; 2 doubtful, 8 negative, 1 negative, giving a positive luetin test, and in 4 of our cases no Wassermann test was made, these patients giving a positive history of syphilis. Out of 38 cases, 35 were treated, the treatment consisting either of administration of salvarsan or inunction of mercury and protoiodide by mouth or mercury salicylate hypodermatically. The results of our cases showed marked improvement in 24 cases, 5 of this number having given a negative Wassermann: slight improvement was present in 6 cases, 1 of which gave a negative Wassermann and 5 a positive Wassermann. Perhaps the reason for so large a number of cases not improving markedly, is due to the fact that they were treated in the dispensary and it was difficult to carry out treatment as prescribed. Three of the patients upon whom a Wassermann test was not made were not treated. One of our patients died following the administration of salvarsan. Two patients died before there was any evidence of improvement, following administration of antiluetic treatment, 1 of meningitis, and the other from amyloid degeneration of the liver. One of our cases gave a negative Wassermann, but a positive luetin test, and improved under syphilitic treatment. In our cases that gave a negative Wassermann we put them on mercurial inunctions for one or two weeks, then stop treatment for two weeks and take another Wassermann test. We have secured positive Wassermann tests upon several such cases and at present this is a routine measure in our hospital. We have found in our experience that the results of Wassermanns done by the old method have been more in accordance with clinical and roentgenographic findings than the Wassermann done after the method of Noguchi.

Dr. Haythorn, director of the Singer Laboratory of the Allegheny General Hospital, has given us the following data on the value of the old Wassermann and Noguchi's modification of it.

"The objections which we have found in our laboratory to the use of the Noguchi system and its modifications for doing the Wassermann reaction may be summarized as follows:

1. The quantities used are very small and are measured by the number of drops from capillary pipettes which are not accurately standardized. Thus the quantities used vary slightly for each test. Because of the very small amounts used the factor of error is great.

2. Of the three reagents which were formerly used to impregnate

paper, amboceptor is the only one which has stood the test of general usage. It has been our experience that if a piece of paper of a certain size, presumably containing a certain amount of amboceptor, was found to hemolize the blood of one person in the presence of a small amount of complement, it often required a piece of the same paper of larger size and a much greater amount of the same complement to hemolize the same amount of blood from another individual, showing a great individual variation in susceptibility to hemolization in human bloods.

3. Quantitative Wassermanns on a comparative basis are impossible with this system.

We have, in favor of the original Wassermann and its modifications where the sheep system is used and controlled in every instance by absorbing out and testing for natural anti-sheep amboceptor in the human sera to be tested:

1. The use of accurately titrated quantitive amounts of each of the reagents, against constant amounts of serum.

2. The opportunity of using accurately titrated and measured amounts of several antigens which are thus placed on a quantitive basis

3. A surer means of controlling all of the factors in the test by daily titrations of measured amounts of amboceptor and complement as well as frequent quantitive titrations of the antigens.

4. The results of six months' parallel tests on the same sera with both systems, which showed several tests to be positive with the Wassermann modifications which were negative with the Noguchi, and in which all of the cases were clinically syphilis and responded more or less to anti-syphilitic treatment.

We have, therefore, adopted the controlled sheep system and are using both cholesterin reinforced and acetone unsoluble antigens."

Observers claim a relatively high percentage of negative Wassermanns in bone syphilis. (Fisher 10%.)

When a Wassermann is negative in a child with bone syphilis one or both parents should be tested.

Keyes found patients with late tubercular condition giving Wassermann, reactions, with a higher percentage of positives with cholesterinized antigen than lipoidal antigen.

Snow and Cooper:

1. "The percentage of non-syphilitic, tuberculous patients whose blood may bind complement with non-cholesterinized antigens is so small as to be practically negligible. Complete complement-fixation, *i.e.*, a strong Wassermann reaction with non- cholesterinized antigen, in a

tuberculous patient, is as adequate presumptive evidence of syphilis as it is in a non-tuberculous.

2. That the sera of non-syphilitic tuberculous patients may give partial—to complete—complement-fixation with cholesterinized antigen in about 31% of cases."

Roentgenograms. 1. Periostitis, either diffuse or local, is accompanied by the formation of an osteoid material which shades off in appearance from a gelatinous-like substance in late deposits to a heavier or calcareous appearance in older deposits. We believe that this deposit in layers is due to successive attacks of periostitis, as in our cases No. XV, in which he had two attacks of periostitis and in which the x-ray showed the different layers; and No. XVII, in which he had successive attacks of periostitis and in which the x-ray shows the different layers. A new layer is laid down in each succeeding attack. With a high-power hand glass the appearance of the topmost layer is that of a feather edge. Here and there over different parts of a bone you may find isolated patches beneath the periosteum raising it from the bone cortex. A marked circumferential thickening of the periosteum is a typical finding in bone syphilis. Ware states that this predominance of periosteal thickening, aside from other bone changes, stands out conspicuously in favor of syphilis.

2. Osteitis may be either diffuse or local; in very early cases there may be no involvement of the cortex shown. A characteristic osteitis is present in the majority of cases at a later date. This is marked by a thickening of the substancia corticalis or of both the substancia corticalis and the spongioid bone. The process is a building around of one layer upon another. In osteitis the distinctions in the shadows perceptible in normal bone become denser (sclerosed); this growth of cortical bone may be either external, producing so-called bowing of the shaft described by Fournier, or internal, encroaching upon or obliterating the medullary cavity. As the process goes on the bone and periosteum may become fused into one mass. Gumma formation generally accompanies osteitis when the process is severe. They are usually single but may be multiple. They may be very small or involve enough of bone thickness to cause a pathological fracture. As the osteitis goes on, areas of necrosis may occur surrounded by areas of greater bone activity. These appear on the roentgenogram as areas of translucency surrounded by areas of osteosclerosis. Typical acute gummata are easily recognized. They have generally a translucent center with destruction of bone; immediately surrounding this central mass there is a dense sclerosed wall and over this, generally, an area of periostitis.

In chronic gummata there is marked sclerosis with localized swelling, destruction of bone usually being present.

3. Osteochondritis.—In congenital cases we have an osteochondritis in which the process begins in the diaphysoepiphyseal junction. The roentgenogram shows a thickening of the bone itself with deformity due to separation of the shaft and epiphyses caused by the disease.

DIFFERENTIAL DIAGNOSIS.

1. *From Tuberculosis.*

In syphilis the process begins in the epiphyseal end of the diaphysis or in the shaft, while in tuberculosis it begins in the epiphyses.

There is marked periosteal thickening in syphilis, while there is little or none in tuberculosis.

In syphilis there is bone proliferation, in tuberculosis bone destruction.

In syphilis there is hypertrophy; in tuberculosis, atrophy.

In syphilis the swelling is due to thickening of bone, while in tuberculosis the swelling is due to thickening of the soft parts.

In syphilis suppurating sinuses are rare while in tuberculosis they are not uncommon.

In syphilis multiple lesions are common, while in tuberculosis they are rare.

2. *From Chronic Pyogenic Osteomyelitis.* (Plate No. XXIII).

In syphilis, periostitis is marked, while in chronic pyogenic osteomyelitis it is not so marked and may be slight or absent.

Osteosclerosis and osteoporosis are more uniform in syphilis than in chronic pyogenic osteomyelitis.

An involucrum is present in chronic pyogenic osteomyelitis but not in syphilis.

New bone formed is thinner and more porous and the borders are thinner and more irregular in chronic pyogenic osteomyelitis than in syphilis.

In chronic pyogenic osteomyelitis there is extensive destruction or absence of bone cortex and a sequestrum large or small, while this is absent in syphilis.

Some cases are hard to differentiate.

3. *From Sarcoma.* (Plate No. XXIV.)

Sarcoma affects the ends of the diaphysis by preference.

There is some disturbance in the minute structure of the bony tissue.

It consists of absorption of lime salts. May find associated increased density in certain areas. This disturbance is comparatively localized and spreads peripherally, the greatest destruction being at the point of origin. Associated is a swelling and new growth. If central sarcoma, the walls of the bone seem to be bursting apart, as it were. In peripheral sarcoma the surface of the bone is found to be rough and uneven and the density shades gradually into the soft tissues. In this peripheral variety the periosteum is often found lifted up highest over the greatest diameter of the tumor and then sloping gradually downward until it becomes a part of the bone again.

4. *From Carcinoma.* (Plate No. XXV).

In carcinoma there is never any tendency to bone hypertrophy, as one would expect from the pathology. It evolves not only the bone substance but the stroma as well, hence we would see an almost complete destruction of the bone substance. The bone substance remaining in the tumor is spongy, porous and eroded.

5. *From Rachitis* (Lovett).

In rachitis the epiphyses may be absent or cloudy in roentgenograms, while in syphilis they are clear and not seriously disturbed.

The changes at the epiphyseal end of the diaphysis appear in syphilis in the fetus or in the new-born, while in rachitis they occur in the first dentition.

Cortical thickening in rachitis is endosteal and is always on the concave side of the curve, while in syphilis it is periosteal and is uniformly on the convex side of the curve.

Exception (See Plate No. XXVI).

The two conditions are very often associated, making the differential diagnosis very difficult.

CASES.

CASE No. 1. A. N., age, 1½ years, white, female, American. Family history: Father had chancre; mother, causeless miscarriage. Began right after weaning, when child refused to walk. When seen child walked with limp, apparently due to trouble in right hip. No limitation of motion or tenderness about hip. No glandular involvement. Wassermann was negative X-Ray showed osteochondritis of the upper diaphysoepiphyseal zone of the right femur, thickening around greater trochanter and proliferation about epiphyses. Treated by injections of mercury and greypowder, and improved. There was no mechanical treatment.

CASE No. 2. E. M. T.; age, 1 year; white, female, American. Family history suggestive of syphilis. Brought in on account of suppurating sinuses on right hand and left foot. Examination shows mul-

Case No. 1.—Congenital syphilis.

tiple bone lesions. X-Ray shows periostitis and circumferential thickening of right ulna, increasing diameter of bone to three times the normal. Typical syphilitic dactylitis of second metacarpal bone of right hand and first and second metatarsal bones of left foot. Wassermann was negative. Was given inunctions of mercury and salvarsan. Died following salvarsan. The involvement is entirely in the shaft and shows the thickening under the periosteum, the epiphysis not involved.

Case No. 3. M. F.; age, 3 years; white, female. Family history contains nothing suggestive of syphilis. Brought in on account of sinus on left hand. Examination shows scar from healed sinus over first metatarsal bone, left foot. Sinus discharging over first metacarpal bone, left hand. No glandular involvement. X-Ray shows marked periostitis along entire shaft of left radius. First metacarpal bone of left hand shows marked thickening of entire shaft with proliferation and necrosis. Marked periostitis along shaft of first metatarsal of left foot. Wassermann positive on mother. Treated by mercury inunctions. Improved.

Case No. 4. C. S.; age, 3 years; white, male, Italian. Family history contains nothing suggestive of syphilis. Child was brought into the dispensary complaining of swelling of the right elbow and a his-

Case No. 2.—Congenital syphilis. Plate A.

Case No. 2.—Congenital syphilis. Plate B.

CASE No. 3.—Congenital syphilis. Plate A.

CASE No. 3.—Congenital syphilis. Plate B.

tory of old sinuses at the lower part of his spine and bow legs. X-Ray shows marked periostitis of an osteoid type, beginning at lower diaphyseal line and involving the lower third of the right humerus. Wassermann positive. The elbow was aspirated and tubercle bacilli were demonstrated by the antiformin method. The patient later died of meningitis. The case was one of double infection.

Case No. 5. J. M.; age, 7 years; white, male. Italian. Family history negative so far as syphilis is concerned. For weeks child complained of limping and of sinus beneath the right knee. On examination there was present a sinus, as above mentioned, and a dactylitis of the middle phalanx. Did not return for observation. Two years later came back complaining of swelling along both legs. No pain. Began insidiously some months ago. X-Ray shows osteoperiostitis of left ulna, with gummatous area. Lateral view of both tibiae shows osteoperiostitis on the convex side of both, with sclerosis. On left tibia two gummata are shown; on the right, one gumma, all in different stages of necrosis. The anteroposterior view of both tibiae shows circumferential thickening. Wassermann positive. Treated with inunctions of mercury. Improved.

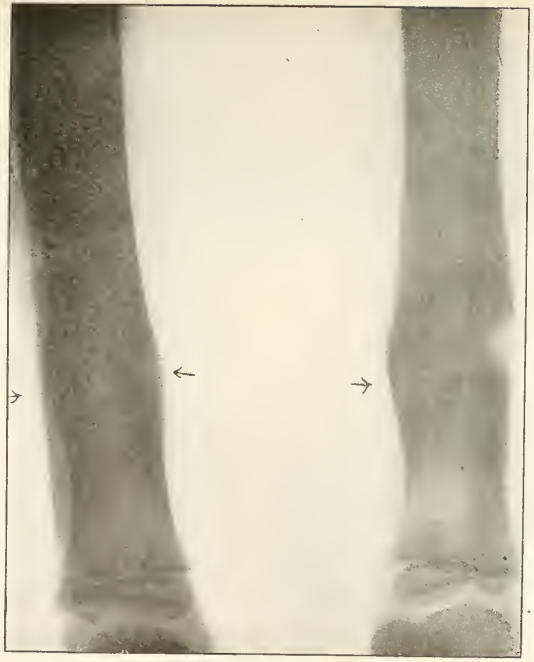
Case No. 6. F. M.; age, 6 years; white, female. American. Family history is suggestive of syphilis as mother had two miscarriages. Patient began to complain four months ago with pain and swelling about both knees and ankles. Since then she has had trouble in walking; the ankles turned in. On examination, patient had flat feet. Marked thickening of periosteum of both tibiae, chiefly of the left. Knee and hip joints normal. Tonsils enlarged and diseased. Teeth in very poor condition, carious notching of upper central incisors which are pointed toward each other. Not typical Hutchinson teeth. X-Ray shows both tibiae have osteoperiostitis with circumferential thickening and marked sclerosis. On right tibia there are two typical subperiosteal gummata with involvement of upper diaphysis in a rarefying process surrounded by sclerosis. On left tibia there is a gumma in the lower end of the diaphysis. The lower end of left fibula is also involved. Wassermann positive. Treated with mercury. Improved.

Case No. 7. H. D.: age, 8 years; white, female, American. Family history negative. Patient was brought to hospital complaining of anterior bow legs; no pain. X-Ray shows marked osteoperiostitis, both tibiae, with cortical thickening and sclerosis and obliteration of medullary cavity in places. Plate B. Case 7, shows same tibia after treatment with absorption of nearly all of the periostitis and the medullary cavity more normal. Wassermann positive. Treated with protiodide of mercury and inunctions. Marked improvement in one year. Plate A, left tibia on admission.

Case No. 8. S. U.; age, 9 years; white, male. Family history: Nothing suggestive of syphilis Began seven months ago, when he com-

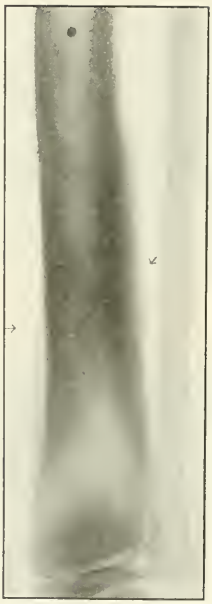
Case No. 5.—Congenital syphilis with gummatous formation. Plate B.

Case No. 5.—Congenital syphilis with gummatous formation. Plate A.

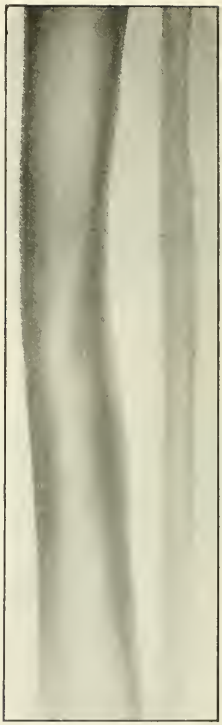


CASE No. 5.—Congenital syphilis with gummatous formation. Plate C.

CASE No. 5.—Congenital syphilis with gummatous formation. Plate D.



Case No. 7.—Congenital syphilis. Plate A.



Case No. 7.—Congenital syphilis, one year after treatment. Plate B.

plained of pain in the left knee and could not walk on it. In bed about three weeks and the knee became swollen and broke open, discharging pus. Taken to the hospital three months later, where he remained one month. Amputation was advised. Examination showed the left knee acutely flexed with marked subluxation of tibia, marked swelling and redness of the knee joint, and pus discharging from sinus on inner aspect of joint. Knee very tender, especially over anterior and inner aspect. Limitation of motion in every direction with attempt to move accompanied by marked pain and muscle spasm. Throat normal except for large tonsils. Skin normal. Chest and abdomen normal.

Case No. 8.—Congenital syphilitic arthritis with gummatous formation. Plate A.

Case No. 8.—Congenital syphilitic arthritis with gummatous formation. Six months afterwards. Plate B.

X-Ray: Lateral view showed a sclerosis at the lower diaphysoepiphyseal zone left femur with evidence of necrosis and new bone formation Anterior posterior view showed involvement of internal condyle with gumma formation surrounded by marked sclerosis. The necrotic area communicates with the joint cavity. Wassermann positive and marked improvement under anti-syphilitic treatment consisting of mercury inunctions and potassium iodide. Von Pirquet negative four different times. Plate A—on admission. Plate B—six months afterwards.

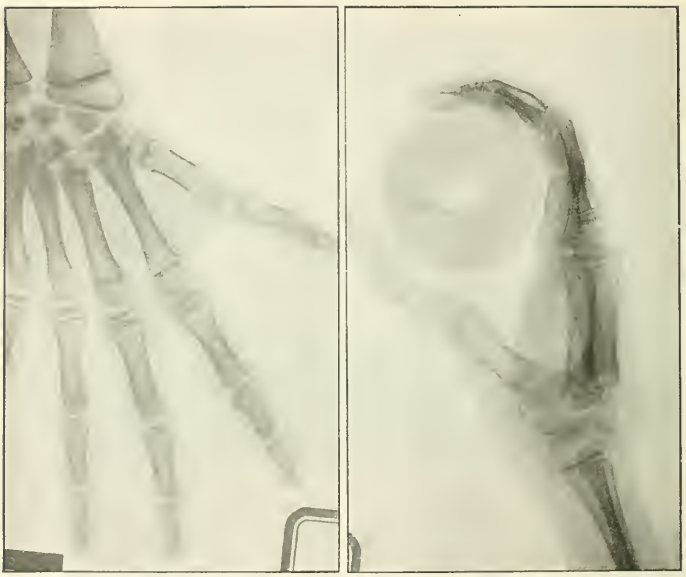
Case No. 9. M. S.; age, 14 years; white, female. Family history: Parents had chronic rheumatism. Began six months ago with pain in the knees. Pain varied in severity, was not increased by walking, but was worse when sitting down at night. Had never been forced to go to bed. Examination showed keratitis. No stigmata of infantile syphilis. Lymphatics—glands in groin and axilla are palpable but the cervical and epitrochlears are not. Right knee—globular shaped swelling on inner side. Enlargement internal condyle of femur. No limitation of motion. Some thickening of capsule and slight swelling on anterior surface right tibia about two inches above ankle. Swelling is tender, immovable, and does not fluctuate. Seems to be periosteal. X-Ray shows selerotic changes at the diaphysoepiphyseal zone with slight periostitis and apparent enlargement of internal condyle. This agrees with findings of Fonndler, who has mentioned enlargement of internal condyle of femur in joint syphilis. Wassermann reaction positive. Improved under anti-syphilitic treatment.

Case No. 10. C. L.: age, 11 years; white, male. Family history contains nothing suggestive of syphilis. Began one year ago with pain in right knee. No history of injury, no pain in any other joint. Pain is intermittent in character, begins in the knee and shoots down to the foot. Pain is mostly at night and worse at night. Knee is tender during attacks of pain. Has always been able to walk, even when pain is present. During pain, feels as if something moved in the knee, but joint never locks and he does not feel anything snap just before the pain leaves. Examination shows no limitation of motion of the right knee and hip, and no pain on motion. There is a tender point at the inner tuberosity of the right tibia. Measurements of right and left knee equal. Reflexes and sensation normal—no stigmata of infantile syphilis of tibia and femur. Proliferative arthritis of cartilage of tibia. Periostitis of patella with sclerosis. Selerosis of epiphyses of both femur and tibia. Wassermann negative. Improved under treatment. Cannot show plate as roentgenogram was broken.

Case No. 11. A.K.: age 10 years; white, female. Family history contains nothing suggestive of syphilis. Began two months ago, when patient fell, injuring her knee. Two weeks later began to complain of pain in her knee, and limped when walking. Sister noticed her knee was swollen. Pain in knee worse at night. No cough or night sweats. Examination shows right knee swollen, fluid in joint. Limitation of movement at knee joint. Pain on movement. Inner side of

CASE No. 13.—Double infection. Congenital syphilis associated with tuberculosis. Plate A, hip joint.

CASE No. 13.—Double infection. Congenital syphilis, associated with tuberculosis. Plate B, spine.



Case No. 13.—Double infection. Congenital syphilis, associated with tuberculosis. Plate C, carpal and metacarpal.

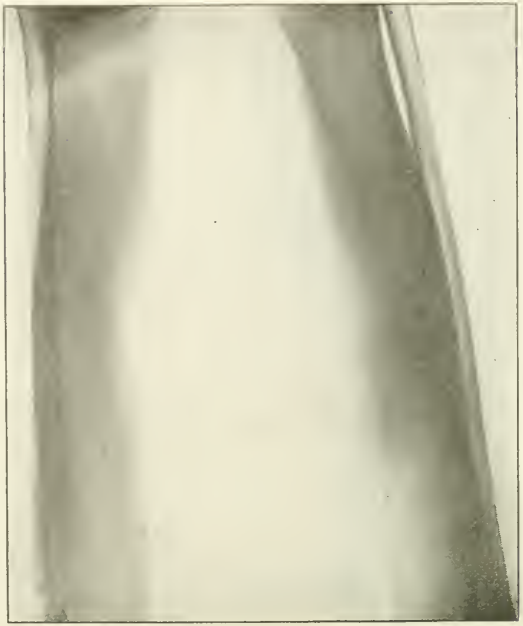
head of tibia enlarged. Right elbow involved, with limitation of motion and pain on manipulation. X-Ray shows a proliferative arthritis of right knee joint, involving the patellla, which is enlarged and sclerosed, and the internal condyle of femur. There is also a proliferative arthritis of right elbow with a periostitis of the radial tubercle. The shaft of the radius looks suspicious of a periostitis. Wassermann negative. Von Pirquet positive. Case improved under anti-syphilitic treatment.

Case No 12. J. R.: age, 6 years; white, female. Family history contains nothing suggestive of syphilis, except one brother had congenital deafness. Began seven months ago with swelling of hands and difficulty in standing and walking; loss of weight. Later all the joints of all the extremities became stiff and painful. There is a marked sclerosis of the vascular system. X-Ray shows destructive process in carpal bones and the articular surfaces of both ulnas. Also coronoid

Case No. 13.—Double infection. Congenital syphilis, associated with tuberculosis. Plate D. Metatarsophalangeal joint.

processes of both ulnas showed a similar process, a suspicion of periostitis of the shaft of the radius. The knee showed sclerosis of both epiphyses with proliferative process and sclerosis of the patella. The picture is one of an infectious arthritis, and is not typical of syphilis —and in presence of a positive Wassermann, was classified as a double infection. Wassermann positive. Treated salvarsan and inunction. Improved.

Case No. 13. A. S.; age, 10 years; white, female, American. Family history negative. The patient gives a past history of tuberculosis of the lungs and the tarsal and carpal bones within the past 14 months. For the past six months there has been pain in the right lumbar region. State tuberculosis dispensary could find no pathology in lungs. Ex-



CASE No. 15.—Acquired syphilis. Osteoperiostitis. Plate A.

CASE No. 15.—Acquired syphilis. Osteoperiostitis. Plate B.

amination showed no spinal spasm, or involvement of hip joint. X-Ray of spine suspicious of a process of the 10th dorsal vertebra. While in hospital on frame, right hip became swollen and painful. Was in bed with extension to right hip and later sent home with a long spica. Seen six months later; showed a sharp kyphosis of lower dorsal region and a rigid right hip. An iritis had developed, which was reported from the eye clinic as specific. X-Ray: Lateral view of spine shows destruction of body of 10th dorsal vertebra, with apparently new bone formation replacing it; also new bone deposit along the anterior border of the bodies of the ninth and eleventh dorsal vertebrae. Right hip is ankylosed and around acetabular margin and along the ilium is new bone production. Plate of right wrist shows an old arthritis of carpometacarpal joints with necrosis of bone. Also at metatarso-phalangeal joint of right big toe. Wassermann negative. Later provocative Wassermann. Improved under antisyphilitic treatment. Another case of double infection.

Case No. 14. J. S., age, 39 years; negro, male, American. Family history negative. Kicked on leg three to four years ago. Been under anti-syphilitic treatment for one year (potassium iodide). Complains of pain and swelling upper part of leg. Pain worse at night. On examination, large swelling at junction of upper and middle thirds of right tibia. Is tender on pressure. X-Ray: Right tibia shows anterior bowing from osteoperiostitis on convex side of upper half of bone. There is obliteration of medullary cavity and a gumma of tibia. Marked periostitis along fibula. Wassermann positive. Refused treatment.

Case No. 15. A. B.; age, 27 years; white, male. German. Family history contains nothing suggestive of syphilis. History of chancre three years ago. Two years ago had painful swelling along both tibiae, which subsided under treatment. Legs began to swell again two weeks ago and became very painful and tender. Pain much worse at night and patient could not sleep. Examination shows no palpable lymphatic glands. Legs swollen below knees, especially tender along anterior border of both tibiae. Some oedema. X-Ray: Both tibiae showed marked osteoperiostitis with circumferential thickening. Sclerosis and obliteration of medullary cavity in places. Also periostitis along fibula. Wassermann positive. Treatment: Salvarsan. Improved.

Case No. 16. H. E. A.; age, 30 years; white, male, American. Family history negative. Married; no children, but wife has had no miscarriages. No history of primary sore. Gonorrhea. About ten years ago had growth on lip diagnosed epithelioma, which was removed, with no recurrence. About three years ago injured elbow playing baseball and noticed he could not straighten left arm. Two years ago X-Ray showed exostosis of external condyle of humerus and this was excised. Following this, was well for about one year and able to play baseball. For past two months has had pain in left elbow; worse at night, although always present and of dull character. X-Ray: Marked osteoperiostitis

Case No. 17.—Acquired syphilis. Syphilitic arthritis.

of external condyle of left humerus with areas of rarefaction and sclerosis and showing previous operation on bone. Also osteoperiostitis of radius and ulna. Wassermann positive. Improved under anti-syphilitic treatment.

Case No. 17. J. P.; age, 30 years; white, male, American. Family history positive for tuberculosis, but nothing suggestive of syphilis. Has been married ten years. Wife had two miscarriages and then a healthy baby. Chancre 15 years ago with local treatment followed by internal medication for one year. Never had lesions of skin or mucous membrane. Rheumatism in right knee and ankle four years ago, but was not confined to bed. About three years ago developed husky voice and cough, which gradually became worse during past few months. Lost 40 pounds in past three years. About one year ago fell and hurt right elbow. Became so sore he could not work. In hospital, and tubercular elbow diagnosed, and cast applied for two months. Did not improve and at present time joint is much worse. Examination shows right

elbow swollen, hot and tender, and limitation of motion. Cannot extend arm past 45°. Examination of throat shows epiglottis thickened and several small ulcerated patches on upper surface. False cords thickened. X-Ray: Marked osteoperiostitis of right ulna and radius, with sclerosis and necrosis. Also osteoporosis of olecranon process. Wassermann positive. Improved under anti-syphilitic treatment.

Case No. 18. T. H.; age, 30 years; white, male, American. Family history negative. Married, and wife had two miscarriages. Rheumatism at 14 years of age. Chancre at 18 years. One year ago had a sore, which he called a bunion, on outer side of foot just back of little toe. Had operation in which bone was removed and wound healed slowly. In hospital seven weeks. Shortly after he began to walk, his right ankle and foot began to swell and has remained swollen ever since. Unable to work on account of pain when standing. No glandular enlargement. Examination shows no fluctuation, no redness or tenderness. Feels like bony thickening. X-Ray: Marked sclerosis of tarsus with new bone formation about inner border of ankle and around astragalus. Also periostitis of fibula. Wassermann positive. Improved under anti-syphilitic treatment.

Case No. 19. C. C.; age, 40 years; white, male, American. Family history negative. History of chancre about 20 years ago. Began one year ago with pain and tenderness in right foot. Has been unable to walk on foot for past six months. Pain not worse at night. Examination shows right foot swollen and tender. No redness or increased local temperature. Limitation of motion in ankle joint. X-Ray shows rarefaction and atrophy of the tarsus and rarefying osteomyelitis of fourth metatarsal bone. No periostitis or sclerosis. Looks more like picture of tuberculosis. Wassermann positive. Did not improve under potassium iodide. Curettement of bone and bismuth paste and then injections of salvarsan. Cured. Fact that potassium iodide made him worse seems to point to bone lesion being tubercular, and the fact that salvarsan, after curettement and orthopædic appliances, cured him, points to syphilis merely as a complication.

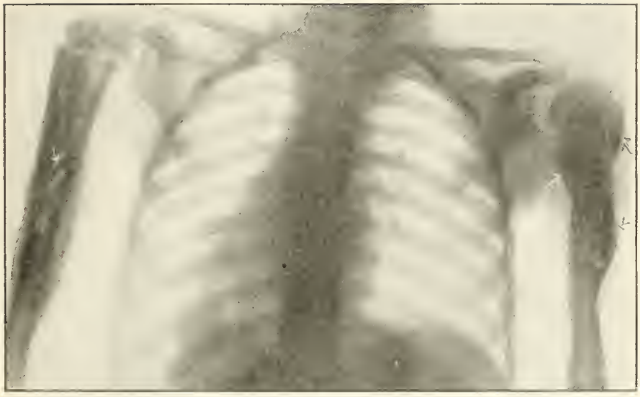
Case No. 20. M. L.; age, 28 years; white, female, American. Family history negative. Is married but has no children. Hurt left knee nine years ago but soon became entirely well. Six weeks ago struck left knee and small abscess formed in same location and healed. Another abscess formed in same location shortly afterwards and is still discharging. Has always been able to walk. On examination, posterior cervical and axillary glands palpable, but no other. Left knee is swollen, tender, red, and fluctuated, but no flexion. Small sinus on outer aspect of knee and an ulcer over the patella, which is punched out in appearance and communicates with bone. X-Ray: Marked sclerosis of entire patella, with periostitis along border, with new bone formation. Wassermann positive. Cleared up on salvarsan.

Case No. 21. F. A. K.; age, 35 years; white, male, American. Fam-

ily history negative. Is married, but has no children. Denies syphilis. General health has been gradually failing for past two years. Has had trouble with stomach for last two or three years, consisting of attacks of pain and vomiting. Had some operation on ankle two years ago for removal of bone. About six months ago had grip. A few days later, while walking in a stiff wind, his left hip felt as though he had sprained it. He noticed an immediate swelling of the hip. His right ankle behaved similarly about the same time. Had cast applied to hip for six weeks. Sputum negative at this time. Since this, has had no treatment except for stomach. Hip and ankle have been gradually getting worse, so that patient is unable to walk without crutches. On examination, Argyll-Robertson pupil was present, reflexes lost, unable to determine Romberg. Left hip was swollen, loose, not painful or red. On movement of joint, no pain or spasm occurred but crepitus felt as if there were loose bone in the joint. The right ankle was swollen, not red, lateral mobility marked, and there was bony enlargement around the ankle. X-Ray showed marked production of new bone along outer border of fibula and marked periostitis along both tibiae and fibula of left leg. Also necrosis with new bone formation of astragalus and internal cuneiform bones and pathological fracture of the os calcis, with sclerosis. New bone formation around left hip. Wassermann not taken. Has improved under local orthopedic treatment in conjunction with anti-syphilitic treatment.

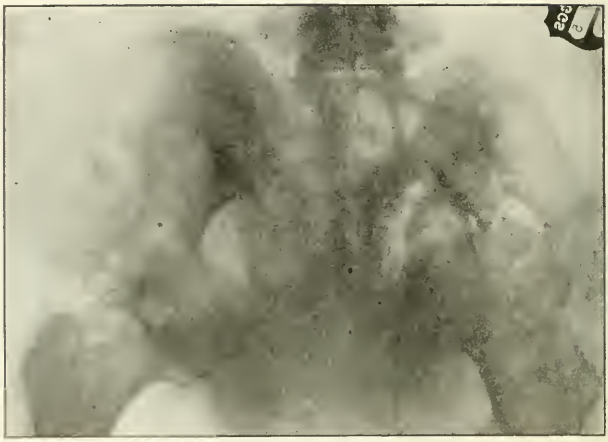
Case No. 22. W. F. D.; age, 59; white, male, American. Family history negative. Is married and has one son, apparently healthy. History of chancre 20 years ago. About five months ago, while lifting a heavy object, injured back and has been unable to work since. About one month following injury, noticed weakness in right leg. Could not walk as well as usual. No pain in legs on walking, at times rheumatic pains. Shortly afterwards noticed weakness in left leg. Lately has noticed curvature of spine. On examination patient stands as if spine were settling down into abdomen. Walks poorly. Spine curve posterior and to right side in lumbar region. Lower part of abdomen is ballooned from paralysis of muscles. Lower limbs are atrophic, resembling muscular dystrophy. Can move legs in all directions but much weaker than normal. Knee jerks absent, Argyll-Robertson pupil present and other signs of preataxic stage of tabes dorsalis. X-Ray shows apparent crushing of second and third lumbar vertebrae on left side, with new bone formation and proliferative periostitis of fourth lumbar vertebra. Wassermann: None taken. Orthopedic treatment of spine.

Case No. 23. Osteomyelitis of humeri. George A., six years old. American, colored child. Swellings of both arms, slightly painful, about a year's duration. Physical examination shows a spindle-shaped swelling at junction of upper and middle thirds of each humerus, encircling the arm; here and there points of fluctuation can be made out. Clinical diagnosis of syphilis was made on account of insidious, non-painful symmetrical growth. Wassermann negative. X-Ray shows chronic osteomyelitis. Right arm: entire right bone is affected, giving a moth-eaten appearance. There are areas of sclerosis which are not regular,



Case No. 23.—Osteomyelitis—humeri.

Case No. 24.—Sarcoma of the humerus.



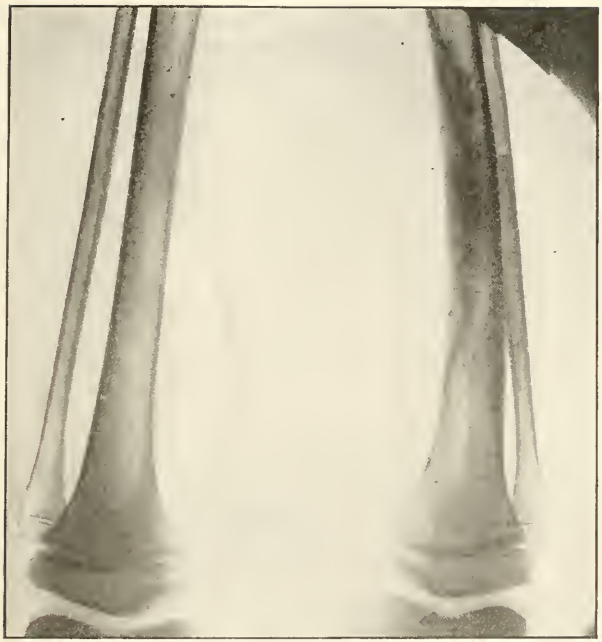
Case No. 25.—General carcinomatosis—pelvis.

but interrupted by areas of necrosis; also shows three or four sequestra. Left arm: entire bone diseased, areas more sclerosed, a great many areas of necrosis and sequestra; also notice considerable periostitis; as differentiated from syphilis the sclerosis is not so dense, sequestra have involvement of the center of the bone and also the epiphysis. Operation confirmed diagnosis. Pure culture of staphylococcus aureus was found.

Case No. 24. Sarcoma, central shaft of humerus. Boy, 8 years old. Three months before noticed slight swelling on humerus, not very painful, was diagnosed exostosis. X-Ray shows spindle- shaped tumor involving the medulla and with a transparent process extending out through the cortex, destroying the bone and pushing the periosteum forth.

Case No. 25. Female, aged 55. Six years ago had amputation for scirrous carcinoma of the breast. Fairly good health for three and one-half years, then she began to complain of pain in the lumbar spine and sacro-iliac region. The pain was constant and she soon became bed-fast. The radiogram showed extensive bony changes in the pelvis, spine and ribs. The process was one of destruction without any attempt of regeneration.

Case No. 26. H. B., aged 9. History of swelling of the legs and pain worse at night. Wassermann positive. X-Ray shows periosteal thickening on the concave side. This case is an exception to Dr. Lovett's statement as detailed under Differentiation from Rachitis.



CASE No. 26.—Syphilis of bone with thickening on the concave side of bone.

CONCLUSION.

1. That syphilis of bones and joints has been largely overlooked in the past from the relatively small number of cases in our hospital records and in the literature. This is naturally more noticeable in the period before the x-ray and Wassermann were in general use. At the present time we exclude syphilis either as a primary or complicating factor, in all cases of bone and joint disease.

2. Syphilis is often present as a complicating factor, or may be merely coincidental, in cases where the bone or joint disease under consideration has some other etiological factor as tuberculosis, osteomyelitis, or rachitis, so that a history of syphilis, the presence of other manifestations of the disease, or a positive Wassermann does not prove that the

bone or joint disease under consideration is syphilitic. In our case No. XIX., a positive history of syphilis was present and a positive Wassermann, but the patient did not improve under antisyphilitic treatment, but became progressively worse, and the bone disease later proved to be tuberculous. A tubercular spine did not improve under treatment, and syphilis was later demonstrated as a complicating factor. One must not forget that a positive Wassermann on one hand or a positive von Pirquet on the other is not *prima facia* evidence that the disease alone exists: that syphilis is an excellent medium for the implantation of tubercular infection, or any other infection.

3. A history of syphilis or the presence of other manifestations of the disease is of value in suggesting the presence of syphilis, but not of any absolute diagnostic value, as it does not exclude the presence of tuberculosis or other bone and joint diseases.

4. In studying symptoms and physical signs alone we have been unable to differentiate syphilis of joints from those due to other etiological factors.

5. We consider the Wassermann reaction very valuable, but only as one point in the diagnosis. In many of our cases the Wassermann reaction was negative, and they were undoubted syphilis, as shown by the x-ray, and their response to antisyphilitic treatment. We have also cases in which the Wassermann was positive and in which the cases proved to be some other bone or joint disease. In some of these cases syphilis was undoubtedly a complicating factor because improvement was not marked until antisyphilitic treatment was instituted. A routine Wassermann is taken on all our cases of bone and joint disease, and in those which are negative but in which the clinical symptoms or roentgenograms suggest syphilis, a provocative Wassermann has been found in some cases.

6. We have found the luetin test of value also, as it is sometimes positive when the Wassermann reaction is negative.

7. The finding of a negative von Pirquet in doubtful cases is of value.

8. We consider the roentgenogram the most valuable factor in the diagnosis of syphilis of bones and joints and in differentiating it from other conditions. In one of our cases there was a history of a primary infection and the Wassermann was positive, but the roentgenogram showed nothing suggestive of syphilis but was suggestive of tuberculosis. On section of bone and pathological examination it was reported tuberculosis. In our cases we have not found syphilitic arthritis without bone involvement, as the roentgenogram of the joint involved may

show nothing, while a roentgenogram of other bones or those contiguous to the joint may show a typical syphilitic osteoperiostitis. In one of our cases where the knee was complained of, a roentgenogram showed typical syphilitic involvement of the radius and ulna. In studying the roentgenogram of cases we have been unable to discern any difference between acquired and congenital cases, with the possible exception of congenital syphilitic osteochondritis.

9. The so-called therapeutic test is also of some value in the diagnosis of obscure bone and joint lesions where an absolute diagnosis cannot be made from the clinical and laboratory findings.

In 38 cases of bone and joint syphilis, 22 cases were congenital and 16 were acquired. In 34 cases having x-ray examinations, only 8 cases had an involvement of one bone alone, and 16 cases had involvement of joint as well as bone.

TABLE I.

Clinical Data	Present	Absent
History of trauma	6	32
History of pain	24	14
Osteocopic pain	13	25
Redness	4	34
Swelling	18	20
Hydrops	3	35

Frequency of Bone Involved	No. of Cases
Tibia	22
Fibula	11
Femur	9
Radius	9
Ulna	9
Humerus	7
Patella	6
Tarsus	5
Metacarpus	5
Vertebrae	4
Metatarsus	3
Phalanges.	2
Carpus	2

Frequency of Joint Involved	No. of Cases
Knee	7
Elbow	6
Ankle	5
Hip	4
Wrist	4
Tarsal	4
Tarsometatarsal	1
Upper radio ulnar	1

In one of these the luetin test was positive.

TABLE II.

X-Ray Findings	Present	Absent
Periostitis	26	8
Cortical thickening	22	12
Proliferation of bone	19	15
Circumferential thickening	13	21
Destruction of cartilage	13	21
Necrosis	11	23
Rarefaction	7	27
Gumma	4	30

Wassermann Reaction	No. of Cases
Positive	24
Negative.	8
Doubtful.	2
Not taken	4

BIBLIOGRAPHY TO JANUARY 1, 1917.

O'REILLY, J. A.: Joint Syphilis. *Missouri State Med. Assn. Jour.*, March, 1915, xii, No. 3.

COFIELD, R. B.: Syphilis of Joints, *Lanect-Clinic*, March 27, 1915, cxiii, No. 13.

O'REILLY, J. A.: Joint Syphilis in Children. AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, April, 1915, xii, No. 4.

KUTH, J. R.: Early Congenital Bone Lues. *Archives of Pediatrics*, 1915, xxxii, 244-255.

KIRMISSON: Syphilis du tibia et du cubitus. *Rev. gen. de clin. et de therap.*, Par., 1915, xxix, 100-103.

ANTONELLI: Hyperostoses naso-lacrymales et de la face, formes de leontiasis ossea. La syphilis congenitale. The Internat. Cong. Med., 1913, Lond., 1914. Sect. ix, Ophthalmol. pt. 2, 101-108.

GUSZMAN, J.: Polyarthritis syphilitica acuta. *Wien. med. Wch.*, 1915, lxv, 185-193.

MANCINI, P.: Le determinazioni articolari della lues. *Med. Nuova*, Rome, 1914, 4, 361, 374, 385.

DELBET, P.: Osteite syphilitique du tibia. *Rev. gen. de clin. et de therap.*, Par., 1913, xxvii, 68.

GESZTI, J: Polyarthritis syphilitica acuta. *Orvisi Lentil.*, Budapest, 1912, lvi, 877.

GUSZMAN, J.: Polyarthritis syphilitica acuta. *Orvosi Lentil.*, Budapest, 1912, lvi, 751-760.

VANZETTI, F.: Periostite sifilitica sperimentale con carie ossea. *Gior. d. r. Accad. di Med. di Jarina*, 1913, 4s. xix, 6.

LEHMAN, J. F.: Clinical Case: Syphilitic Condition of the Patella. *West Canada Med. Jour.*, Winnipeg, 1913, vii, 246-249.

ADDISON, O. L.: Syphilitic Disease of Bones and Joints in Children. *Med. Press and Circ.*, Lond., 1913, N. S. xcv, 333, 657.

OWEN, S. A.: Syphilitic Diseases of Joints and Bones in Childhood. Their Differential Diagnosis from the Medical Standpoint. *Med. Press and Circ.*, Lond., 1913, N. S. xcvi, 318-320.

SKILLERN, P. G., JR.: Syphilis in the Etiology of Fibrous Osteitis. *Am. Jour. Med. Sci.*, 1913, cxlvi, 531-535.

GREGORY, M. S., AND KARPAS, M. J.: Syphilitic Bone Disease of the Skull. *Jour. Nerv. and Mental Dis.*, 1913, xl, 651-659.

BINGOLD, KONRAD: Beitrag zur diffusen Knochen Lues. (Berlin). Nurnb., 1913, G. Heydolph, 28 p. 5 pl.

BOIKOFF, V. M: Effect of Ehrlich's Preparation upon the Bony Skeleton. *Russk. J. Kozhn. I Ven. Boliezn.*, Mosk., 1912, xxiv, 179-187.

ADDISON, O.: Syphilitic Disease of Joints and Bones in Children. *West. Lond. Med. Jour.*, 1913, xviii, 85-91, Discussion, 115-126.

ROZENBLAT, YA. M., AND GRINFELD, A. I.: Influence of Salvarsan upon the Bones in Syphilis. *Syezd rossiysk. Khirurg.*, Mosk., 1912, xi, 93.

BROCA, A.: Syphilis héréditaire des a. t. articulations. *Rev. prat. d'obst. et de pacdiat.*, Par., 1913, xxvi, 1, 33, 65, 97, 129.

COVISA, J. S.: Caso notable de sifilis osea. *Rev. Clin. de Madrid*, 1913, ix, 457-459.

ENO, F.: Report of a Case of Gumma of Bony and Cartilaginous Tissue. Proc. Canal Zone Med. Assoc., 1912, 4. P. 1. 75.

KEDROFF, S. I.: Cases of Syphilitic Polyarthritis. *Vrach. Gaz.*, S. Peterb., 1913, xx, 230.

KLEMPTNER, M.: Pseudo-rheumatism of the Joints Following Syphilis. *Vrach. Gaz.*, S. Peterb., 1913, xx, 231.

LEVESQUE: Accident tertiaire de l'ethmoide et du maxillaire supérieur gauche; phagedeniome ténébrant de la face; mort par cachexie. *Rev. hebd. de larymgol., etc.*, Par., 1913, ii, 129-133.

RUBIN, J.: Ueber akute Polyarthritis in zweiten Inkubations Stadium der Syphilis. *Arch. f. Dermat. et. Syph.*, 1913, cxviii, 61-76.

FRANKEL, EUGEN: Die kongenitale Knochen-syphilis im Röntgenbilde, Hamb., 1911. *L. Grafe & Sillem*, 21 p. 8 pl.

GAUCHER, GOUGEROT & MILBAUT: Ostéopériostite cervicale: mal de Pott syphilitique sous-occipital: Hémiplegie droite guérie. Par., 1911, vi, 937-939.

BONNEAU, R.: De la syphilis osseuse. *Paris Chirurg.*, 1911, ii, 863.

LE FUR, R.: Un cas intéressant de syphilis osseuse peutêtre associé avec de la tuberculose ostéo-articulaire. *Paris Chirurg.*, 1911, iii, 858-860.

BONNET, L. M.: Arthrite syphilitique du coude avec fistulation et lésions osseuses considérables. *Lyon Méd.*, 1912, cxviii, 136-138.

FITZWILLIAMS, S. C. L.: Syphilitic Affections of Bones Met with in Childhood. *Brit. J. Child. Dis.*, 1913, ix, 97-111.

CLOGNE, PAUL: Des localisations périostiques et osseuses de la syphilis secondaire. Paris, 1911, *Jocye & Cie.*, 59 p.

LOMBES, JEAN: Considerations sur la spina ventosa syphilitique. Toulouse, 1911., Sebille, 68 p.

LETT, H: Syphilitic Periostitis of the Tibia. *Clin. J.*, Lond., 1912-1913, xl, 31.

PIED, H.: Mal de Pott syphilitique d'origine probablement héréditaire guéri par le traitement spécifique. *Ann. de dermat. et syph.*, Par., 1912, 8S. iii, 298-301.

BELOT, J. and NATHAN: Sur la syphilis osseuse. *Bul. et mem. Soc. de radiol. med. de Par.*, 1912, iv, 131-133.

KIRMISSON: A propos d'une ostéite syphilitique du tibia; caractères différentiels des ostéites chroniques; tubérculose, syphilis, ostéomyelite prolongée. *Clinique*, Par., 1912, vii, 369-372.

KIENBOCK, R.: Ueber mit die Protrusion des Pfannenbodens ein hergehenden Erkrankungen des Hüftegelenks, und ihre Beziehungen zur Arthritis gonorrhoica und Arthropathie bei Tabes. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Hamb., 1911-12, xviii, 280-396.

AUVRAY: Un cas de mal de Pott syphilitique. *Rev. gen. de clin et de therap.*, Par., 1912, xxvi, 369-372.

SHOOP, F. J.: X-ray in Differential Diagnosis Between Gumma and Osteosarcoma. *S. M. j. Dermat. and G. U. Dis.*, 1912, xvi, 355.

DUBOIS-HAVENITH: Gomme ulcerée tubérculeuse ou syphilitique, ostéo-périostite du maxillaire. *Policlin. Brus.*, 1912, xxi, 221.

GANGOLPHE, M.: Syphilis osseuse préhistorique. *Lyon Méd.*, 1912, cxix, 189-200.

THERSTAPPEN: Regeneration of Bone after Injection of Salvarsan. *Münch. med. Wochnschr.*, Dec. 20, 1910, lvii, No. 51.

BINE, R.: Syphilitic Osteoperiostitis. *California State J. Med.*, Nov., 1911, ix, No. 11.

GJESTLAND, G.: Case of Syphilitic Periostitis with Remittent Fever. *Norsk Magazin for Laegevidenskaben*, July, 1912, lxiii, No. 7.

EVANGELISTA, A.: Syphilitic lesions in the spine. *Riforma Medica*, Naples, 1913, xxix, Nos. 1, 2, 3.

PHILBERT, MAURICE: Aspects radiographiques de syphilis héréditaire, tuberculose et ostéomyelite diaphysaires des os longs chez les enfants. Paris, 1913, G. Steinheil, 110, p., No. 295.

HALIPRE, A.: Heredo-syphilis: lesions ostéo-périostées; nécessité dans certains cas de l'emploi successif du traitement ancien et du néo-salvarsan. *Rev. Méd. de Normandie*, Rouen, 1913, 341-344.

MOUCHET and MEAUX SAINT-MARC: Sur les formes anormales de l'hérédo-syphilis tardive des os longs. (Rapp. de C. Lenormant.) *Bull. et mem. de Soc. de Chir de Par.*, 1913, N. S., xxxix, 1347-1358.

SAVARIAUD: Les manifestations osseuses et articulaires de l'hérédo-syphilis chez l'enfant. *J. de med. de Par.*, 1913, 2 S., xxv, 875.

WILE, U. J.: Arthropathy in Secondary Syphilis. *J. Cutan. Dis. incl. Syph.*, 1914, xxxii, 20-23.

AXHAUSEN: Beiträge zur Knochen und Gelenksyphilis. *Berl. klin. Wochnschr.*, 1913, S. 2361-2369.

FITZWILLIAMS, D. C. L.: Syphilitic Affections of Bones in Childhood. *Clin. J.*, Lond., 1914, xliii, 33-41.

VEREBELY, T.: Ersatz der syphilitischen Defekte des Oberarmknochen durch Transplantation. *Pest. med.-chir. Presse*, Budapest, 1914, S. 16.

GASTON and CHANTASSIN: Polyarthrite progréssive déformante, ankylosante généralisée, probablement d'origine syphilique héréditaire. *Bull. Soc. franc. de dermat. et syph.*, Par., 1913, xxiv, 547-549.

MAUCLAIRE and BADIN: Genu valgum et lésions osseuses multiples de nature probablement syphilitique. *Bull. et mem. Soc. de. chir. de Par.*, 1914, N. S., xl, 63.

BECK, O: Bone Conduction in Syphilis. *Anns. of Otol., Rhinol., and Laryngol.*, 1913, xxii, 1099-1109.

O'REILLY, A.: Joint Syphilis. AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, 1914, xi, p. 431.

BADIN, P. V.: Syphilis osseuse héréditaire tardive. *Presse Méd.*, Paris., 1914, xxii, 240-242.

BRIAL and PATGES: Ostéopérioste syphilitique d'un tibia. *J. de med. de Bordeaux.*, 1914, xliv, 235.

GAUCHER AND BARRY: À propos de deux cas de mal vertébral syphilitique sous-occipital. *Ann. d. mal. ven.*, Par., 1914, ix, 246-255.

MUTEL: Mal de Pott syphilitique chez un hérédo-syphilitique. *Rev. med. de Vest*, Nancy., 1914, xlvi, 174-176.

PERITZ, G.: Syphilis der Wirbelsäule. *Charité-Ann.*, Berl., 1913, xxxvii, 65-82.

COURTIN, J.: Lésions hérédo-syphilitiques des diaphyses des os longs. *Gaz. hebd. d. soc. med. de Bordeaux*, 1914, xxxv, 270.

MERY AND HENZER: Hérédo-syphilitique des deux tibiae à forme inflammatoire. *Bull. Soc. de pediat. de Par.*, 1914, xvi, 391-321.

BALZER, DE CHAMPTASSIN AND GALLIOR: Arthrite hérédo-syphilitique du coude guérie par la mechanotherapie associé avec du traitement specifique. *Bull. Soc. franc. de dermat. et syph.*, Par., 1914, xxv, 212.

GUYOT, J.: Ostéo-arthrite syphilitique du coude chez une adulte. *J. de med. de Bordeaux*, 1914, xliv, 364.

NICHOLAS, MOUTOT AND GATE: Deux cas de syphilis cranièenne à larges séquetres. *Province med.*, Par., 1914, xxv, 237-239.

TRUSLOW, W.: Hereditary Syphilis in Bones and Joints. *Long Island M. J.*, 1914, viii, 299.

ROGUE, CARDIER AND RENDU: Pseudo-tumeur blanche syphilitique du poignet. *Lyon Med.*, 1914, cxxii, 1485-1487.

HUNT, J. R.: Syphilis of the Vertebral Column; Its Symptomatology and Neural complications. *Am. J. Med Sciences*, 1914. *cxlviii*, 164-179.

PHEMISTER, D. B.: Necrotic Bone and the Subsequent Changes Which It Undergoes. *J.A.M.A.*, Jan. 16, 1915, lxiv, 211.

LYDSTON, G. F.: Case of Syphilis of Cranium and Spine. *Medical Record*, Jan. 9, 1915, lxxxvii, No. 2.

PENTAGNA, O.: Tardy Deformed Growth of the Long Bones in Child of 2½ Years with Inherited Syphilis; Retrogression to Normal Under Specific Treatment. *Pediatria.*, Naples, Feb., 1915, xxiii, No. 2.

ARKIN, L.: Case of Auto-transplantation of Bone for Nasal Deformity Due to Syphilis. *Boston M. and S. J.*, May 6, 1915, clxxii, No. 18, page 672.

BARBOSA, N.: Syphilitic Arthritis. *Brazil-Médico*, Rio de Janeiro, May 8, 1914, xxviii, No. 18.

BROWN, P.: Further Consideration of Roentgen Diagnosis of Luetic Skeletal Manifestations. *Am. J. Roentgenology*, June, 1914, i, No. 8.

RAICES, J. A.: Sifilis ossea. *Semana Médica*, Buenos Aires, Jan. 15, 1914, xxi, No. 3.

TOUSSAINT, H.: Revail et localisation de la syphilis osseuse à la suite des coupe de form. *Bull. et mem. Soc. de Chir. de Par.*, 1915, N. S., xli, 477-482.

PUHLMANN, W. A.: Die Arthritis luetica simplex. Leipzig, 1909.

ROCHE, J. P.: Contribution à l'étude des fractures pathologiques chez les syphilitiques. Montpellier, 1907.

Balzer, Combes and Fouquet: Nécrose syphilitique du maxillaire; pneumonie avec albuminurie; plasite aigue mercurielle. *Rev. de stomatol.*, Par., 1904, xi, 535-540.

Dreschfeld, J.: Case of Spontaneous Fractures in a Patient Affected with Syphilis. *Med. Times and Gaz.*, Lond., 1881, ii, 283, 362.

Lopez, G.: Caquexia sifilítica; fractures multiples espontáneas. *Gac. san. de Barcel.*, 1907, xix, 1-8.

Meriel: Radiographie d'une fracture pathologique syphilitique. *Bull. et mem. Soc. anat. de Par.*, 1901, lxxvi, 417-419.

Quinn, W. A.: Case of Syphilis with Ankylosis of the Mandible. *J. Cutan. Dis. incl. Syph.*, 1907, xxv, 276, Abstract.

Tavernier, A.: Contribution à l'étude des fractures des os chez les syphilitiques. *J. d. mal. cutan. et syph.*, Par., 1896, viii, 709-718.

Solomon: Arthrites multiples suppurés pneumoccoques chez un syphilitique héréditaire. *Ann. de med. et chir. inf.*, Par., 1903, vii, 411-415.

Bandelot, G.: Ostéo-arthropathie avec contracture dans la syphilis héréditaire tardive. Paris, 1900.

Bernard, C. E. E.: La maladie osseuse de Paget et l'hérédo-syphilis osseuse. Lille, 1910.

Gilbert, P.: Disjonction épiphysaire des nouveaux-nés syphilitiques. Paris, 1899.

Merleau, A.: Contribution a l'étude des affections osseuses dans hérédo-syphilis. Paris, 1899.

Moses, H.: Beitrag sum Wesen der kongenital-syphilitischen Tibia en lame de sabre (Königsberg). Tübingen, 1904.

Rebeyrolle, E.: Contribution a l'étude de la syphilis osseuse héréditaire tardive dans des manifestations épiphysaires et articulaires. Paris, 1902.

Saint-Pierre, M.: Contribution a l'étude des arthropathies de la syphilis héréditaire tardive. Lyon, 1900.

Saucet, P. E. A.: Contribution a l'étude des arthropathies de la syphilis héréditaire tardive. (Bordeaux). Periguex, 1904.

Shvetsoff, J. M.: Pathologo-anatomical Alterations in the Epiphyses of Long Tubal Bones in Children in Congenital Syphilis. (St. Petersburg). Revel., 1898.

Voinier, A. E. E.: Contribution a l'étude des ostéo-arthropathies de la syphilis héréditaire. Nancy, 1910.

Addison, O. S.: Syphilitic Osteoperiostitis. *Proc. Roy. Soc. Med.*, Lond., 1908-9, ii, Sect. Stud. Dis. Child., 171.

Arnozan: Ostéite gommeuse due à la syphilis héréditaire chez une jeune fille de vingt ans. *Bull. Soc. d'anat. et physiol. de Bordeaux*, 1894, xv, 118-120.

Baginsky, A.: Bone Lesions of Hereditary Syphilis in Children. *International Clinics*, 1899, 9 S., iii, 224-233.

Broca, A.: Syphilis héréditaire tardive des os; gommes et hyperostoses circonscrites. *Tribune med.*, Par., 1904, 2 S., xxxvi, 645-648.

Cuff, A.: A Case of Congenital Syphilis With Curious Bone Lesions. *Quart. M. J.*, Sheffield, 1895-6-14, 144-149.

Drennan, C. T.: Osseous Changes in Hereditary Syphilis. *Memphis M.*, 1898, xviii, 556-562.

Étienne, G.: Ostéopathies hérédo-syphilitiques et maladie de Paget. *Rev. med. de l'est*, Nancy, 1904, xxxvi, 343.

Ervan: Severe Inherited Syphilis without Parental History. Multiple Epiphysitis. *Polyclinic*, London, 1901, v, 48.

Feulard, H.: Syphilis héréditaire; déformations craniènnes; ostéopériostite gommeuse de l'extremité inférieure du tibia droit. *Ann. de dermat. et syph.*, Par., 1895, 3 S., vi, 219-221.

Fitzwilliams, D. C. L.: A Case of Congenital Syphilis Showing Widespread Periostitis of the Long Bones. *Proc. Roy. Soc. Med.*, Lond., 1908-9, ii, Sect. Stud. Dis. Child., 21.

Francon, A.: Déformation du tibia en lame de sabre probablement d'origine hérédo-syphilitique. *Bull. Soc. franc. de dermat. et syph.*, Par., 1898, ix, 62-65.

Gaucher: Les osteopathies de la syphilis héréditaire tertiaire. Rev. gen. de *clin. et de therap.*, Par., 1911, xxv, 627-629.

GAYET: Dystrophie osseuse d' origine hérédo-syphilitique. *Lyon Méd.*, 1908, cxi, 423-434.

GIBORE, E.: Syphilis osseuse héréditaire. *Rev. gén. de clin. et de therap.*, Par., 1909, xxiii, 788-791.

HALL, J. B.: A Case of Syphilitic Fibro-spongioid Osteitis. *The Lancet*, 1900, i, 1875.

HUTCHINSON, J.: Periostitis of Bones Near the Elbow Joint in an Infant; Hereditary Syphilis. *Archives of Surgery*, London, 1899, x, 260.

JAMES, A.: A Case of Hereditary Syphilitic Osteitis. *Scot. M. and S. J.*, Edinb., 1899, v, 301-305.

JEANSELME: Hérédo-syphilis et arthrite. *Rev. gén. de. clin. et de therap.*, Par., 1909, xxiii, 248.

JOACHIMSTHAL, G.: Syphilis congénitale avec déformation osseuses. *Ann. d'orthop. et de chir. prat.*, Par., 1893, vi, 369-375.

PENTAGNA, O.: Late Manifestation of Hereditary Syphilis Causing Ostitis and Periostitis of the Long Bones in a Child of 28 Months. Entirely Cured by Specific Treatment. *La Pediatria*, xxiii, Feb., 1915, p. 105-112. AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, July, 1915, 142.

COON, CLARENCE E.: Bone and Joint Syphilis. AMERICAN JOURNAL OF ORTHOPEDIC SURGERY, xxiv, 211, June, 1915.

COUES, W. PEARCE: Luetic Bursopathy of Verneuil; Report of a Case of the Congenital Type. *Boston Med. and Surg. Jour.*, July 1, 1915, clxxii, 18.

STEIN, H. C.: Syphilitic Arthritis. *Medical Record*, Sept. 18, 1915, lxxxviii, 472.

GAUCHER AND LEVY-BING: Des ostéopathies de l'hérédo-syphilis quarternaire. *Ann. de mal. ven.*, Par., 1908, i, 22-30.

KARSNER, H. T.: Congenital Syphilitic Osteochondritis. *Proc. Path. Soc.*, Phila., 1910, N.B., xiii, 54.

KAUFMAN, L. R.: Hereditary Syphilis of Tibia, Fibula, Radius and Ulna and Frontal Bone. *Hamorop. M. Soc.*, N. Y., 1909, liii, 214.

KRASNOBOYOFF, T. F.: Gummatous Syphilis in a Child 4 Months Old with Multiple Joint and Phalangeal Involvement. *Dietsk. Med. Mosk.*, 1903, viii, 388-390.

LANNELONGUE: Syphilis osseuse héréditaire tardive, type Paget; types infantile et adolescent, types de l'adulte et du vieillard. *Ann. de chir. et d'orthop.*, Par., 1903, xvi, 103-115.

LEGG, T. P.: A Case of Congenital Syphilitic Osteo-periostitis of the Femur of an Infant. *Med. Press and Circ.*, Lond., 1907, N. S., lxxxiv, 443.

MERCER, A. C.: Clinical Remarks on Cases of Congenital Syphilis and Rickets. *Buffalo M. and S. J.*, 1892-3, xxxii, 411-417.

MORGAN, J. H.: A Discussion on Congenital Syphilitic Manifestations in Bones and Joints. *Brit. M. J.*, 1895, ii, 697, 700.

MOUCHET AND ROUGET: Arthropathie hérédo-syphilitique du genou droit et syphilis héréditaire des tibias. *Bull. Soc. de pediat. de Par.*, 1910, xii, 225.

MOUSSOUS, A.: Syphilis héréditaire tardive avec arthropathies multiples. *Mem. et Bull. de méd. et chir. de Bordeaux*, (1909) 1901, 426-430.

NAMMACK, C. E.: A Case of Skull Deformity from Inherited Syphilis. *N. Y. Med. Jour.*, 1895, lxi, 710.

OBERWARTH: Vorstellung eines Falles von congenitaler Syphills mit Spontanfrakturen. *Berl. klin. Wochenschr.*, 1906, xliii, 683.

ORTH, J.: Eine Leber and Knochen mit kongenital-syphilitschen Veränderungen.: Verhandl. d. Gesellsch. deutsch. Naturf. u. Aerzte, Königsb., 1910, Leipz., 1911, lxxxii, pt. 2, 22.

PARKINSON, J. P.: A Case of Inherited Syphilis, with Infantilism, Bone, Joint and Visceral Lesions. *Rep. Soc. Study Dis. Child.*, Lond., 1907-8, viii, 255-258.

PARTRIDGE, A. A. H.: Unusual Joint Changes in a Child the Subject of Inherited Syphills. *Rep. Soc. Study. Dis. Child.*, Lond., 1902-3, iii, 230-233.

PREISER, G.: Ueber Knochenveränderungen bei Lues congenita tarda. *Fortschr. a. d. Geb. d. Röntgenstrahlen*. Hamb., 1908, xii, 81-88.

REINER, M.: Beiträge zur Kenntniss der Ostitis deformans heredo-syphilitica. *Wien. med. Presse*, 1901, xlii, 585-591.

SAUNDERS, A.: A Case of Syphilitic Periostitis. *West Lond. M. J.*, 1910, xv, 43.

SCHICK, B.: Periostitis ossificans luetica in einem Kinde. *Mitt. d. Gesellsch. f. inn. Med. u. Kinderh. in Wien.*, 1907, vi, 3

SÉGARD, M.: Ostéite hérédo-syphilitique. *Clinique*, Par., 1909, iv, 616.

SLUKA, E.: Fall von Periostitis luetica. *Mitt. d. Gesellsch. f. inn. Med. u. Kinderh. in Wien.*, 1909, viii, 133.

SMITH, E.: A Case of Congenital Syphilis of Elbow Joint. *West Lond. M. J.*, 1911, xvi, 44.

SPIELER, F.: Osteoperiostitis luetica und exzessives Längenwachstum der rechten Tibia. *Mitt. d. Gesellsch. f. inn. Med. u. Kinderh. in Wien.*, 1905, iv, 258.

STADLER, E.: Ueber Knochenerkrankung bei Lues hereditaria tarda. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Hamb., 1907-8, xi, 82-85.

SUTHERLAND, G. A.: Some Bone Lesions of Congenital Syphilis. *Brit. J. Child. Dis., London*, 1908, v, 52-54.

THIBIERGE, G.: Deux cas de syphilis héréditaire avec lésions osseuses multiples et exostose medio-palatine. *Bull. Soc. franc. de dermat. et syph.*, Par., 1898, ix, 58-62.

TSCHERNIAWSKI, W. A.: Ueber einen Fall von Osteo-chondritis und Dactylitis luetica hereditaria. *Ztschr. f. orthop. Chir.*, Stuttg., 1906, xvi, 306-321.

TUBBY, A. H.: Congenital Syphilitic Curvature of the Tibia. *Clin. J.*, Lond., 1894, iv, 316.

TUBBY, A. H.: The Bone and Joint Lesions in Hereditary Syphilis. *Brit. J. Dis. Chil.*, Lond., 1908, v, 49-52.

VILLEMIN: Un cas de syphilis osseuse héréditaire. *Gaz. d. mal. enfant*, (etc.) Par., 1900, ii, 57.

VILLEMIN: L'ostéite syphilitique héréditaire. *Rev. gén. de clin. et de therap.*, Par., 1908, xxii, 97-99.

WEBER, F. P.: A Note on Congenital Syphilitic Osteitis Deformans. *Brit. J. Dis. Child.*, Lond., 1908, v, 83-86.

WILSON, W. R.: Syphilitic Affection of the Skin and Osseus System in the Newborn. *Am. J. Med. Sciences*, 1904, N.S., cxxvii, 458-463.

WINFIELD, J. M.: Osteopathies of Quarternary Syphilis (Gaucher); A Report of the Examination of 46 Orthopædic Cases. *J. Cutan. Dis. incl. Syph.*, 1909, xxvii, 394-397.

METAYER, M.: Les manifestations articulaires de la syphilis héréditaire tardive. Paris, 1904.

BROCA, A.: Syphilis héréditaire tardive des os; hyperostose diaphysaire diffuse. *Tribune Med.*, Par., 1904, 2 S., xxxvi, 613-616.

GORDILLO, L.: Lesiones óseas de la sífilis hereditaria tarda. *An. d. Chir. y Med. Argent.*, Buenos Aires, 1895, xviii, 578, 586.

MONNIER, U.: Un cas de syphilis héréditaire tardive à manifestations ostéo-périostiques gommeuses du crâne. *Gaz. Med. de Nantes*, 1895-6, xiv, 35.

PALHIER: Syphilis héréditaire tardive; hyperostoses des deux malléolaires inférieurs. *Bull. Soc. anat. clin. de Lille*, 1888, iii, 136-141.

PATRICK, J.: Inherited Syphilis. *Glasgow M. J.*, 1904, lxi, 185-190.

POTTER, H. N.: Tardy Hereditary Syphilis of the Bone. *Med. Brief*, St. Louis, 1896, xxiv, 1649-1651.

POTTER, H. N.: Can Tardy Hereditary Syphilis of the Bone be Successfully Treated by the Inoculation of Measles? *Pediatrics*, 1898, v, 191-194.

ANDERSON, T. McC. Affection of the Knee-joints Consequent upon Hereditary Syphilis. *Glasgow M. J.*, 1895, xliv, 416.

WHITNEY, JAS. L. AND W. I. BALDWIN.: Syphilis of the Spine; Its Frequency and the Value of Its Characteristic Lesions as a Diagnostic Sign of Syphilis. *Jour. A. M. A.*, Dec. 4, 1915, lxv, 1989-1993. Disc. 1993, 1994.

WHITNEY, JAMES G.: A Statistical Study of Syphilis as Seen in the Out-Patient Department of the University of California Hospital. *Jour. A. M. A.*, Dec. 4, 1915, lxv, 1986-1989.

MURA, S.: Connection between Rachitis and Inherited Syphilis. *Pediatria*, Naples, Oct., 1915, xxiii, No. 10.

HIGGINS, W. H.: Luetic Arthropathies. *Am. Jour. Med. Sci.*, November, 1915, cl.

TAYLOR, ROBT. W.: Syphilitic Lesions of the Joints in Hereditary and Acquired Infection. *Med. Record*, May 26, 1906, p. 620

FRAUENTHAL, HENRY H.: Syphilitic Arthritis. *Medical Record*, Vol. 69, May 26, 1906, p. 822.

CLONIC SPASMODIC CONTRACTIONS, ILLUSTRATED BY A CASE OF CLONIC SPASMODIC CONTRACTION OF THE MUSCLES AROUND THE HIP JOINT.*

BY E. LAMING EVANS, F.R.C.S., LONDON.

MR. PRESIDENT AND GENTLEMEN:

AFTER the many learned papers read before this Association at yesterday's meeting, I place before you, today, with very great diffidence, a problem which in part belongs to orthopædic surgery and in part to neurology. My excuse for bringing it before your notice is, partly, on account of its rarity, partly on account of the principles underlying the treatment, and, in some measure, on account of the success which, up to date, has attended the treatment. The case is one of spasmodic snapping hip.

E. W., aged 21, was first seen by me in October, 1914. She complained of pain on the outer side of the upper part of the left thigh. During 1911-1913 she had been treated by Scott's dressing and a leather splint for an affection of the left knee, at two metropolitan hospitals.

The condition of the left hip, namely, swelling and tenderness below the middle of Poupart's ligament, together with the report that the x-ray examination showed erosion of the head of the femur, in conjunction with the history of the affection of the left knee, led to the diagnosis of suspected tuberculous coxitis. She was treated for three months in an infirmary and for one and one-fourth years in a sanatorium.

I next saw this patient in November, 1916. She then presented a complete change of symptoms. All movements of the hip joint were free and there was an absence of all swelling in or around the joint. When the hip joint was in the position of extension, that is, when the patient was standing up or lying flat, movements of internal rotation of the femur occurred, and each movement was attended with an audible, visible, and palpable snap. The movements were produced by the internal rotators of the hip joint, and the snap was caused by the great trochanter passing under the anterior fibres of the gluteus maximus. The contractions were of spasmodic character: abrupt, as if produced by an electric current: painful; were not stopped by her will, attention or distraction: occurred as frequently as 49 times to the minute: and ceased when the hip was flexed and abducted.

The case was one of clonic spasmodic contraction in which the reflex arc consisted of the afferent or sensory fibres from the anterior

* A paper read before the British Orthopædic Association, July 27, 1918.

fibres of the gluteus maximus, or hip joint, a spinal centre, and the efferent or motor fibres to the internal rotators of the hip. It was distinguished from the spasmodic tics inasmuch as the movements were characterized by extreme abruptness, lack of purpose, the limitation of the anatomical area, their painful character, the absence of any irresistible impulse and of the sense of satisfaction upon consummation.

The cause in clonic spasmodic contractions has to be sought in some irritation in the reflex arc: and inasmuch as the motor impulses ceased when the thigh was flexed and abducted, it was reasonable to assume that the irritative lesion was not present in the course of the efferent fibres to the gluteus medius and minimus, nor in the spinal cord: and, as this position relieves tension of the anterior fibres of the gluteus maximus upon the great trochanter, it was safe to assume that the course of stimulation arose in the afferent fibres from the hip joint or the gluteus maximus.

In January, 1917, the leg was fixed in plaster-of-Paris with the thigh abducted and slightly flexed. All spasmodic movements were checked. The plaster was removed in May, 1917, when the movements returned and continued.

In November, 1917, hypnotic suggestion failed to relieve the condition.

In January, 1918, I operated, exposing the tensor fasciae femoris, and dividing it transversely together with the anterior fibres of the gluteus maximus. The muscles were dissected upwards and the nerve supply exsected as far as they were exposed. At the operation nothing abnormal in the anatomical arrangements of the tensor fasciae femoris nor of the gluteus maximus were found. The spasmodic contraction produced the same signs as a snapping hip in which various pathological conditions have been described—thickening of the ilio-tibial band—adventitious sausage-shaped masses of tissue, or bands connecting the gluteus maximus to the ilio-tibial band. But none of these conditions was found.

The immediate result of the operation was a cessation of all spasmodic movement, which has continued to the present time. I here show you the patient.

The case presents several points of interest to the orthopædic surgeon. So far, nothwithstanding a fairly extensive search into the literature of snapping hips and clonic spasmodic contractions, I have failed to find any similar case. In Heully's exhaustive articles on "Hanche à ressort" he quotes a case by Rochet of voluntary tic or

habit spasm, associated with snapping hip, but the original description in the *Journal de Bordeaux* is not available for reference in the Royal Society of Medicine Library: but it was clearly a case of tic and not spasmodic contraction.

The cause of the afferent stimulus is speculative. The previous history of the case might lead to the supposition that the exciting cause of the reflex spasm was in the hip joint after cure of an arthritis which may or may not have been tuberculous in nature. The explanation of the cure must then be sought in the lessened intra-articular pressure by the relief of tension upon the great trochanter by division of the anterior fibres of the gluteus maximus. On the other hand, the afferent stimulus may have arisen in the gluteus maximus, though nothing abnormal was seen at the operation. Like many cases of spasmodic torticollis of subcortical or bulbar origin, the reflex arc was established without demonstrable lesion, but unlike those cases which are treated and cured by exsection of the efferent or motor nerves along which spasmodic impulses pass, in the case under review, cure was effected by relief of tension of the efferent or sensory nerves conveying the afferent impulses to the centre of the arc, and without interference of the normal function of the muscles which carried out the spasmodic movements.

DISCUSSION.

THE PRESIDENT: This is a very interesting case, and Mr. Laming Evans gave me an opportunity of seeing the patient when the movements were most marked, when it almost seemed that the head of the femur was slipping over the bony ridge, and we both seemed in some doubt as to what had happened. The curious thing about it is that the movements are those of internal rotation, and the operation which cured it apparently did not deal with any internal rotators, and it is a question whether it was not cured by the fact of operation, and, therefore, whether any long incision would not have cured it. At any rate, the treatment adopted by Mr. Laming Evans was entirely successful, and the patient is none the worse for having a bit of the gluteus maximus and tensi femoris divided.

LIEUT.-COL. MACDONALD (New Zealand Medical Corps): I have recently had a case which was practically on all fours with this one, except that the muscles affected were not the same as in this case. In the case I speak of, the origin, I think, was toxic. The condition came on whilst the patient, a soldier, was recovering from typhoid fever. It seemed to bear a definite relationship to a toxic cause. The muscle affected in that case was the rectus abdominis, and the movements took place at about the same rate, and could not be controlled by the patient. They varied from 45 to 50 per minute and were not accompanied by pain. During the time the movements lasted, about four months, the patient suffered from an acid form of indigestion. One peculiar point about the case was that every third or fourth contraction was accompanied by a contraction of the internal oblique. I treated it as a functional case, and my reason for that was—and I think it is a fairly sound one—that when there is a rhythmical contraction of muscle, if it is not most marked at the extremity

of the limb or body, you can be pretty certain it is functional; for instance, if it affects only the muscles near the large joints. I think the condition in this present case also is functional. The method of treatment I used was that which I adopt in all such conditions. It began with strict isolation. The patient was put on milk and water and was isolated; he was not allowed any external stimulant, nor was he allowed to read, or work or smoke, or do anthing but think about himself. After a week of that preliminary treatment the patient is brought into a receptive condition, and more forcible treatment is given. I began to tetanize with a tetanizing coil the rectus abdominis. After a few minutes of that, the muscle lost its contraction. The movements continued during sleep. I do not know whether that was so in Mr. Laming Evans' case. Each day the improvement lasted a longer time, and in about a week the contractions ceased and the patient became practically normal, although occasionally, under the influence of excitement, the trouble recurred, when he could now check it. I think dealing with spasms of any kind, either tonic or clonic, by the method of plaster or fixation, is not a good plan. I think there are two ways of dealing with these conditions, which are useful. One of them is that which I have indicated, by a preliminary course of isolation, then applying some local treatment which will have some effect on the muscles. In the case of tonic spasm, a good plan is slow re-education of the opposing muscles by a stimulus. In cases of contraction of the hand, which used to give a great deal of trouble, I have got success in practically all cases by using strong faradization of the contracted muscles which are in spasm and then applying gentle faradism to the opposing muscles, getting the patient to make an effort to help himself. From the moment the patient helps himself, you are on the road to success and you can be certain you will arrive at a cure.

Mr. Laming Evans (in reply): Against the functional theory is the fact that when my patient flexed and abducted the leg the spasm ceased. If it had been functional, I think the spasm would have gone on in any position. With regard to persistence during sleep, the patient says unless she got the leg adducted and flexed, it was too painful for her to sleep, but in that posture she could sleep. I did not mention the fact that we could not isolate these girls; we had no beds available. Even in England, now it is most difficult to isolate neurotic patients. She was treated by means of the faradic brush and in other ways as if her case was functional, for a considerable time, but it did not improve her. I think the fact that it persisted so long, and also that it was rather painful, are against the functional idea, as also the fact that there was a history of coxitis. It seems to indicate that there is some source of irritation in the reflex arc.

THE MENSURGRAPH: A METHOD OF MEASURING AND PLOTTING ORTHOPÆDIC DEFORMITIES BY PHOTOGRAPHY.

BY THERON WENDELL KILMER, M.D., NEW YORK.

This method consists in using the photographic camera as an instrument of precision the same as a surveyor uses the transit.

A white stool (Fig. 1) has painted upon it two sets of black footprints. One set faces towards the front, while the other set faces at right angles to these. A person standing upon the first set would, therefore face the camera, while a person standing upon the second set would be sideways, or profile, to the camera.

The camera is placed at a fixed distance in front of the stool. This distance is determined by experiment, the focus of the lens used being an important factor in determining the above distance. I found that with a lens of nine and one-half inches focus that the camera must be exactly one hundred and twenty-four inches, or ten feet and four inches, in front of the stool; it also was found that the camera must be exactly forty-nine and one-half inches from the floor. These distances are carefully measured, two small tacks being driven into the floor, said points located by means of a plumb-bob attached to camera and to the stool. These two points must be exact in order that the number of inches on the person correspond relatively to the number of inches on the ground-glass of the camera. It was found that a child measuring four feet and five inches, if placed on the stool, would measure four inches and five-twelfths when measured by a rule on the ground-glass of the camera. Across the front of the white stool were painted two black lines (Fig. 1), one horizontal and the other dropping vertically from the horizontal line. Upon the ground-glass of the camera there were two similar lines which accurately cover the lines on the stool. By this means I know that my ground-glass and subject are always in register, similar to the cross-hairs of a surveyor's transit coinciding with the cross-lines on the rodman's target. After photographing the child upon a five by seven plate, I place over the negative in printing, a screen or scale (Fig. 2). This screen consists of a

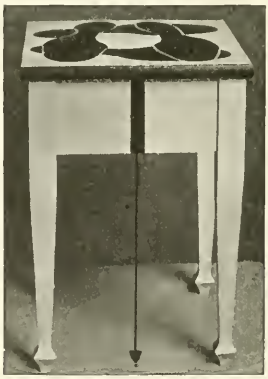


Fig. 1.

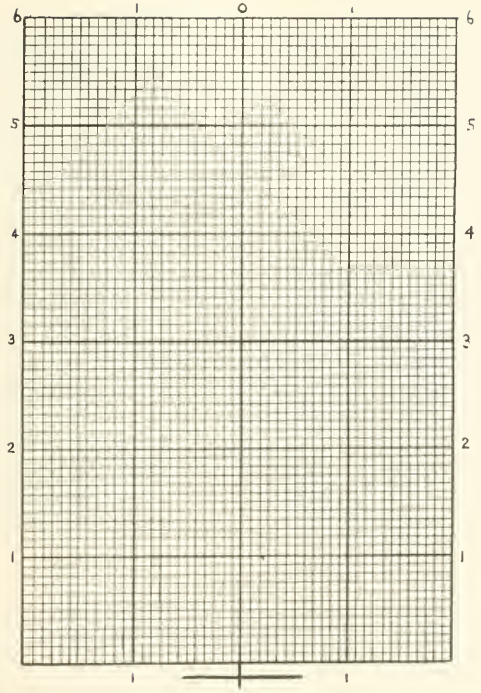


FIG. 2.

semi-opaque substance upon which are drawn transparent lines. The two cross-hair lines on the screen are placed in register with the cross-hair stool lines on the photographic plate negative. The result is a scale of square inches upon the child corresponding to the number of square inches on the screen; negligible errors are practically eliminated, as the cross-hair lines of the plate and screen always match up. Looking at Fig. 3, we see that the height in inches is fifty-three, or four feet and five inches, which corresponds to the height of this child when measured by a measuring rod. Notice in Fig. 3 how both positions of the child are of the same height, showing the accuracy of the method.

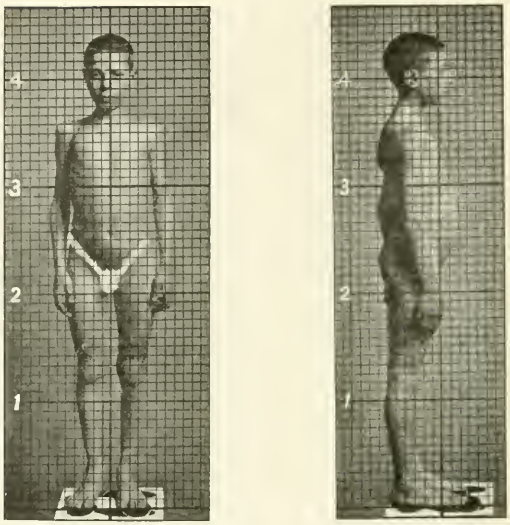


Fig. 3.

These measure-picture records which I have termed mensurgraphs would seem to me to be of value in denoting the progress of improvement of orthopædie cases of all types. For instance, a stooping attitude and its correction might be very graphically shown in lateral pictures, with the difference of the line of balance in the two postures. An anchylosed knee may be illustrated, and its improvement may be shown better by use of this screen method of plates than by any number of tape measurements. Incorrect postures at a school desk may also be recorded by this method. The use of the ruled screen does not in any way mar the value of the photograph, as the child is not taken through the screen, but the screen is superimposed upon the photograph.

Let us for a moment look again at Fig. 3. Suppose it be desired to take even a finer measurement of any individual portion of this subject: a knee, arm, face, etc. Let us take the face, for example. The face, from top of head to point of chin measures eight inches; if you count the squares between these two points you will find that there are

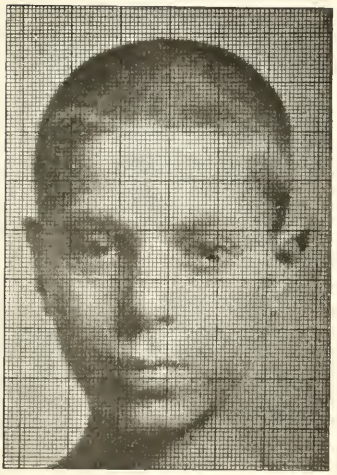


Fig. 4.

eight of them. We now take the negative and make an enlargement of the head, which enlargement, when measured by rule upon the enlarging-easel, is to be exactly eight inches. After obtaining this enlargement, we place upon it a large, ruled screen divided into square inches, each square again divided into twelfths of an inch. In Fig. 4 we see this enlargement and screen combined. By this enlarged method we are able to measure developmental changes, deformities, growths, skin lesions, etc., by one-twelfth of an inch, thus having a method of permanently recording any change in size. In conclusion, this method of mensuration by means of photography seems to me to offer a new field of great value along orthopædic lines, namely, those of being able by the mensurgraph to permanently record the measurement of growth, deformity and development of the human body.

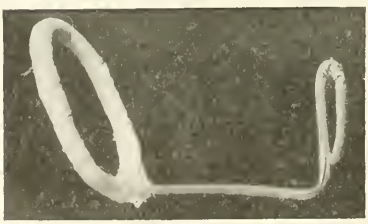
METACARPAL AND PHALANGEAL TRACTION SPLINT.

BY HENRY L. HESS, M.D., KANSAS CITY, MO., CAPTAIN, M. C., U. S. ARMY,
Orthopædic Surgeon, Base Hospital No. 77, France.

In the treatment of fractures occurring among war injuries the predominance of compound comminuted fractures is the most striking feature. In dealing with this type of injury many new problems as to proper appliances have arisen which have led to the suggestion of a number of new and valuable devices. For one group of these fractures, namely, those of the metacarpals and phalanges it has occurred to me that a more practical appliance than that heretofore used could be devised.

As many of these fractures are infected and require frequent dressing, the same recognized principles of treatment should be instituted as in the case of similar fractures of other long bones, namely, that of traction. This traction should also be applied in such a manner that the best results may be obtained with the least possible discomfort to the patient.

With this point in view I have attempted to devise a finger traction splint by means of which these results may be accomplished without



immobilizing the entire arm, allowing the patient free use of the arm, and permitting frequent surgical dressing, without disturbance of the fragments.

The splint, which is interchangeable, right or left, is constructed of heavy steel wire No. 5 (Roebling gauge), with a padded collar through which the fingers are admitted. On the ulnar side of the hand, the collar rests on the styloid process. On the radial side it rests between the thumb and index finger, which point is a natural weight-bearing surface. From this latter point on the collar arises the extension arm of the splint, which projects to two inches beyond the ends of the fingers, where it is bent at right angle and overhangs the tips of the fingers. Here a backward loop is made which forms an elongated eye through which the traction cords are passed, thus avoiding pressure on the ends of the fingers. This extension arm can be adjusted in such a manner as to procure traction on any one or on all of the fingers. The traction cords are attached to the dorsal and palmar surfaces of the finger by means of adhesive plaster, and are then passed through the elongated eye of the extension arm, crossing within the eye, and again above the eye where they are tied. Traction is obtained by twisting the traction cords by means of a small stick or nail inserted between the cords immediately above the eye of the splint. When sufficient traction is obtained, the stick or nail is secured to the splint by means of adhesive. A cotton pad should be applied over the dressing on the palmar and dorsal surfaces of the hand, and made secure with a bandage.

The accompanying photographs, for which I am indebted to Lt.-Col. W. M. L. Coplin, show the splint applied to the ring finger of the right hand.

GUNSHOT INJURIES TO THE JOINTS.

BY ROBERT B. OSGOOD, LIEUT.-COLONEL, M.C., BOSTON.

In discussing gunshot injuries of the joints, certain fairly recent changes of conception regarding the resistance of the synovial membrane must be borne in mind.

No one will question the serious nature of synovial infections. When they occur, the constitutional effect is often profound and the treatment is difficult.

It is a fact, however, already familiar to surgeons who have done much joint work, and emphasized very strikingly by the great number of gunshot wounds of the present war, that the synovial membrane and joint structures possess very marked resistance to infection. If the invasion does not contain an overwhelming number of bacteria and appropriate treatment be instituted early, the synovia may be counted on to take care of the residual infection. With proper after-treatment, joint function may be confidently expected also.

Principles Underlying Treatment.

The principles underlying the treatment of joint injuries concern themselves first with transport of the wounded. In transport the importance of gentleness and most complete fixation, coupled, if possible, with traction, cannot be over-estimated.

No man whose wounds suggest the possibility of any joint involvement should be allowed to leave the battle field or the first dressing station where splints are available without the most adequate protection of his potentially dangerous injury.

In the upper extremity, Murray's hinged modification of the Thomas leg splint, slung to a stretcher bar, and, in the lower extremity, the Thomas leg splint, offer this adequate protection, affording not only fixation by means of slings and flat splints and side bars, but also integral traction by means of adhesive extension straps fastened about the notch in the lower end of the splint pulling against the bony counter point in the groin or axilla. In the arm only slight traction is ever necessary. In the leg, more traction is advisable, but if the extension is applied early, before the muscle spasm has become severe, much less force is necessary than if it is applied for the first time at a later period. The leg should be flexed at the hip and the splint slung on a stretcher bar, as with the arm injuries.

In case of extra or intra capsular hip injuries, the long Liston splint, interrupted by an iron bridge, by the bending of which abduction is secured, may be used for transport only. If this is employed, it should be made into a traction splint, by means of a perineal band passing through the holes at the top of the splint, while by means of anklet or extension straps, traction is maintained to the adjustable foot piece.

We should make no compromise with slings, angular arm splints, posterior leg splints, etc., etc.; fixation, plus traction, is the only safe rule to follow in the transport of joint injuries.

Serving with the British it has been our repeated experience to receive at the General Hospital seriously inflamed joints in which the necessity for an extensive secondary operation seemed imminent, which were shown by the records to have left the casualty clearing station, or evacuation hospital, in an excellent quiescent condition. These usually were transported in posterior wooden splints, with foot pieces; the thigh and toes were fixed, but the leg had twisted invariably; and added to the imperfect immobilization, there was often undue constriction, unevenly distributed. If we were able to attend to these cases quickly and apply a Thomas splint with traction and fixation, most of these threatening joints quieted down after a stormy two or three days. Continuous fair weather might just as well have been enjoyed if they had been properly splinted nearer the front.

FIXATION.

After transport, the traction and fixation should be continued, coupled usually with hot fomentations. We are speaking now of those joints which have had the initial cleaning operation, the so called debridement. This fixation and some degree of traction should be maintained until the temperature drops, the surface heat and swelling become less intense, the patient once or twice a day being encouraged to make slight active motions of his joint. Varying degrees of fixation should be continued for parts of the day and always at night, as function returns.

EARLY OPERATION AND CLOSURE OF THE SYNOVIAL CAVITY.

All through the early years of the war, the problem of the treatment of wounds was the problem of sepsis. It is a problem still, but it is a problem which seems in a fair way of being solved. Some late sepsis is bound to occur, but may be fairly well controlled by the Carrel-Dakin treatment if the solution is fresh and properly made and the

technique is carefully followed. By far the most important contribution to the solution of the problem of infection in joint wounds is what is known as the technique of early closure.

It has been demonstrated by Lemaitre and others that a very large proportion of all wounds may be safely closed by primary suture, if by a careful and non-destructive dissection all the devitalized traumatized tissue be removed within a few hours of the reception of the wound. By a few hours is meant from five to twelve. Certain other wounds operated upon later than this may be dissected and provisional sutures placed, and a large proportion of these closed by delayed primary suture. Many of the frankly septic wounds may be treated by the Carrel-Dakin method and when the smears from the depths show only one or two bacteria to the microscopic field, may be safely closed by secondary suture.

The important measures in joint wounds, if the case has been received before frank and extensive suppuration has set in, are: (1) the careful removal of all the devitalized tissue by the technique described by Lemaitre. (2) The removal of the foreign bodies, clothing and missiles, by following with the utmost gentleness and avoidance of trauma to the uninjured tissue in the trail of the missile, and, (3) the thorough and prolonged washing-out of the synovial cavity, after the removal of the foreign bodies. The solution used seems not to be of supreme importance, saline, ether, eusol, weak bichloride, sterile water, seem to give the same results. It is the thoroughness of the irrigation, reaching all the recesses of the joint, that counts. A soft rubber catheter serves well, and may be inserted, in case of a single opening, into the opposite side of the joint and moved about gently into the deepest recesses, the fluid being allowed to escape from the opening by the side of the entering catheter. The edges may be gently closed about the catheter, while the fluid is allowed to flow in, and the synovial cavity slightly ballooned, then the fluid is allowed to escape quickly by releasing the edges of the wound. There must be a large enough opening in the synovia to allow free escape of the fluid and pieces of clothing or small bone fragments. The irrigation should last from ten to fifteen minutes.

Following the dissection and the thorough irrigation, the synovia is tightly closed with interrupted catgut suture, and, if the case has been received within a few hours of the injury and the extent of damage of the superficial tissues is not too great, these structures are sutured as well. In any event, the small rubber tissue drain is inserted only down to the synovia, but not into the synovial cavity. In the cases received later, the Carrel-Dakin tubes may be inserted into the super-

ficial wound. A very large proportion of these cases eventually recover good joint motion without a second opening of the joint cavity. There is often a tight synovitis, surface heat, tenderness, and some temperature for several days.

In former times, we should rarely have possessed the courage to treat such alarming symptoms by fixation and traction alone, but should have advised further surgery, which, in the light of the war experience, we now know would have been ill-advised.

In cases of severely infected joints received later than twenty hours, it is probably best not to attempt complete closure, but to insert the Carrel tubes into the joint cavity and institute thorough Carrel-Dakin treatment.

Many of these joints may be expected to become partially or completely ankylosed, but the infection can usually be thus controlled, and the popliteal space rarely gives trouble. This war has taught us the value of flexibility, the necessity of submitting to evidence to the point of changing our conception if the evidence is trustworthy. No instance of this is more striking than in the heresy of Willems, which has apparently become gospel. The frankly septic pus discharging joint, if the patient recovered, became ankylosed. Willems began to insist on active motion at an early date and the recovery of the patient and the retention of motion in the joint became the expectation, not the rarity. The rule now established over seas in relation to frankly septic joints which have been subjected to operation and drainage is that active use up to the limit of toleration will do good rather than harm. The principle is stimulation of the circulation and drainage of the joint cavity lymph spaces by active motion. Passive motion is forbidden. As soon as the drainage operation has been performed a soft dressing is applied. Six hours rest is given and then the patient is encouraged to move the joint himself in spite of pain. This is repeated at least every three hours until it is possible for him to get out of bed. The pain of active use gradually lessens from day to day. The patient is actually wakened from sleep the night following his operation for this movement.

A certain amount of actual weight bearing is encouraged as soon as the patient is up.

RADIOGRAPHIC EXAMINATION

At the very earliest opportunity, radiographs should be taken in at least two planes, in all joint injuries. It is not sufficient to subject the case to fluoroscopic examination.

When stereoscopic methods of examination are available, they are often of great value.

Types of Wounds.

In considering the treatment of joint wounds in more detail, we shall attempt to roughly classify the lesions. We shall divide them into the following types:

1. CONTUSIONS WITH ONLY BRUISES OR SLIGHT LACERATIONS OF THE SKIN.

Such wounds are received from large pieces of shell or bodies, such as bricks, stones, pieces of timber, etc., which may be propelled with force when a shell explodes in the vicinity of the soldier. They may or may not be complicated by fracture, and this fracture may or may not involve the joint surfaces. In every case, a radiograph should be taken either stereoscopically or in two planes. We desire to emphasize again the fact that fluoroscopic examination is not sufficient to discover small cracks which may extend to the joints.

ABSENCE OF FRACTURES.

If there is no fracture after such careful radioscopic examination, fixation in a Thomas splint, with light traction for transport, and a continuance of this apparatus or a split or bridged plaster when the base hospital is reached, will result in subsidence of the synovitis. Hot fomentations should be applied for several days.

If in the knee joint the distention is extremely tight and painful, it is easy to relieve this by aspiration. If there is reason to believe the fluid to be blood, this procedure is actually advisable. A certain amount of distention by fluid is to be desired, since by it inflamed and bruised surfaces are kept apart and adhesions between the surfaces are less likely to form.

Active voluntary motion, without weight-bearing, should be instituted within a week if the tension and tenderness are diminishing. There should be freedom from weight-bearing for at least two weeks, and an amount of protection varying from a split plaster to a tight bandage for at least a month. This bandage may at first be applied over a voluminous sheet wadding or cotton wool dressing. Later on a flannel or compress cloth bandage, cut on the bias and slightly elastic, may be substituted. We deprecate the use of the rubber elastic bandage, since it causes so much atrophy of the muscles. If this atrophy is extreme to the point of paralysis, the graduated electrical contractions by means of the Faradic current and Bristow coil method are very useful, especially in the knee where great weakness of the quadriceps and of the vastus internus division in particular is not uncommon.

PRESENCE OF FRACTURE.

(*a*) *Without displacement.* If a fracture or fractures exist without displacement, the same procedures, coupled with a longer fixation and a longer freedom from weight-bearing, should result in the restoration of good function.

(*b*) *With displacement.* If displacement exists, this must be reduced, not necessarily at one sitting, but by means of gentle manipulation, followed by continuous traction. Here the Thomas splints, or, at the Base, the overhead frame and weight and counterweight traction, are most useful. Open operation after subsidence of the traumatic inflammation if these methods are not successful.

(*c*) *Loose fragments.* If a loose fragment of the articular surface is discovered by means of the x-ray, its removal is usually to be advised, since the union of this fragment, even if it can be replaced by manipulation, is rare. The presence of the synovial fluid bathing surfaces where the solution of continuity has occurred, seems to inhibit the growth of the cementing tissue. The time for the removal of this fragment is not, as a rule, immediately following the injury, but rather after the acute condition has begun to subside under fixation and traction and hot fomentation.

Sometimes, of course, the damage to the articular surface is so great, and the fragments so numerous that there is no recourse but excision, but this should be reserved for a last resort. We have seen many badly smashed articular bone ends form useful joints if the fragments were in close apposition and represented more impactions than loose fractures.

If there is an impaction of the main ends and one or more loose fragments, the removal of these should be delayed until the union of the impacted portions is so firm that the manipulation necessary at operation to reach and remove the loose fragments is not likely to disturb the impactions.

In all joint operations, the fact that the synovial membrane is resistant to infection, should not lead us to relax in the slightest degree the following of a most scrupulous aseptic technique and the gentlest of manipulations and tissue handling. The exploration should be entirely instrumental and not digital. In the presence of contused tissue, in which resistance to infection is always lowered, the approach to the joint should be through healthy tissue.

2. PERFORATING OR "THROUGH AND THROUGH" WOUNDS BY BAYONET OR RIFLE AND MACHINE GUN BULLETS

In the vast majority of cases, these perforating wounds leave no foreign body in their tract. The bayonet may possibly do so, but our experience and that of other men show that generally serious infections do not follow these "through and through" wounds if early fixation and moderate traction be applied.

If the projectile has caused a fracture, the same general plan of treatment which has been advised under non-perforating contusions should be followed. The case, whether a fracture does or does not exist, should be watched most carefully and continuously. Infection by some form of gas-producing bacilli is most to be feared, and if tension increases and crepitation is to be felt, a still closer watch must be kept, but, even in their presence, an operation is not always necessary, for we have seen such cases subside without operation. In one case, a fragment of shrapnel was discovered several months after the injury, imbedded in the femoral condyle close to the articular surface and surrounded by a small osteomyelitic cavity. It was thought best to remove this and Major Harvey Cushing tunnelled the condyle with a cranial burr without opening the joint from the external surface. The fragment of shrapnel was removed, a culture of the small osteomyelitic cavity, in which were a few drops of pus, was taken, and showed a pure culture of a gas-producing bacillus. A small rubber tissue drain was inserted into the bone cavity. In a few days the joint was distended and definite characteristic crepitation could be felt in various places. The tension and crepitation disappeared, however, without further operation and the external wound soon healed without sinus. In this case we knew the nature of the infecting organism and were able to observe the successful resistance of the joint tissues to this infection.

In all perforating, through and through wounds, it is much safer to take a culture from the depths of the trail on extrance. If the culture reveals any one organism, it is safer to watch the case under fixation and traction. A combination which the surgeon should especially dread is that of streptococcus with the gas-producing bacilli. It is probably safer if this combination exists to open and wash out the joint. It is very possible that a greater experience will lead us to advise the insertion of Carrel-Dakin tubes into the joint and treatment by this method for several days, after the temperature becomes normal.

3. PENETRATING WOUNDS.

By penetrating wounds, we mean those wounds caused by bayonets, shell fragments, shrapnel balls, and machine gun and rifle bullets, which enter the joint but do not emerge from the tissues.

With the exception of the penetrating bayonet wounds, the problem of the missile as a foreign body always presents itself, and the bayonet every now and then carries in a piece of clothing or chips off a piece of bone. In any event, the absolute necessity of the most careful radioscopic examination and accurate localization is evident.

In discussing the treatment, we will suppose that a foreign body exists in the joint. If the missile has passed through and is lodged in the superficial tissues, one can never be sure that bits of clothing do not remain in the joint and represent the most serious foci of infection. We will suppose that the culture does not show either the hemolytic streptococcus or a combination of the gas-producing group with the streptococcus.

(*a*) CASES RECEIVED WITHIN FIFTEEN OR TWENTY HOURS OF THE INJURY.

If the case be received within 15 or 20 hours, it is best to open the joint and remove all foreign bodies and completely detached portions of bone; great gentleness in handling the tissues is of the utmost importance. The approach should be by the path of the missile and a most scrupulous dissection and removal of all devitalized tissue should precede the joint exploration.

On reaching the joint, the gloved hands should be passed through a strong antiseptic, washed in sterile water or salt solution, and fresh instruments used. After the removal of the foreign body or bodies, the joint should be thoroughly irrigated by the method above described, and the synovia closed tight. Usually the external wound in these cases may be closed as well, but if there has been too great loss of tissue and skin, the wound should be treated as a sterile wound. There should never be more drainage planned than that afforded by one or two small rubber tissue drains or silk-worm gut setons running down to, but not passing through, the synovial membrane.

The joint should be immobilized in a Thomas arm or leg splint with moderate traction. Motion should be begun as outlined above.

(*b*) CASES RECEIVED LATER THAN TWENTY HOURS AFTER INJURY.

If the radioscopic examination reveals a foreign body or bodies the safest rule to follow is immediate operation and removal. The subse-

quent procedures are always a question of judgment aided by bacteriological examination. In many cases practice has demonstrated that it may be still safe to thoroughly wash out the joint as above described and to close tightly, the superficial tissues being left open, or partially open, and a small rubber tissue drain inserted, extending to the synovia but not into the joint.

Until a certain amount of experience and power of judgment has been acquired, it is probably safer to insert Carrel tubes into the joint cavity and institute the Carrel-Dakin treatment. There will be a greater danger of limitation of future mobility and function to be expected, but a lesser danger of serious infection, often difficult to control.

We have personally observed many cases received late, in which, in spite of the presence of foreign bodies, the signs of acute infection subsided under fixation, traction, hot fomentations, etc., that is, cases in which the natural resisting forces of the body were superior to the threatened immediate overwhelming attack of the infecting agents. If in these late cases with small foreign bodies the active inflammatory joint reaction is subsiding in spite of the presence of the foreign body, it may well be wiser to wait till the resistance of the body to the infecting agent is at its height before operating for its removal.

This time of heightened resistance, in our experience, seemed to be, as a rule, from the tenth to the fourteenth day. To teach this waiting policy as a routine is dangerous and one must always bear in mind the fact that the long continued presence of irritating agents, foreign bodies and low grade infections leads to synovial and bone changes which may progress to ankylosis and destroy future function.

The Carrel-Dakin treatment should be continued until the temperature remains normal for two or three days.

The same policy in regard to motion should be followed as outlined for the perforating wounds. Always active, never passive, and always conditioned by pain.

4. COMPLICATING FRACTURES.

The presence of fracture has the same bearing on the treatment as with the perforating, through-and-through wounds, and the operative procedures should be the same. Attempts at motion, of course, must be delayed.

The early removal of loose fragments and the Carrel-Dakin treatment offer, in our opinion, a better chance for future function than does

early excision, and while injuries to the cartilage always predispose to infection and slow restoration of function, we are inclined to advise the more conservative course.

The excision of frankly septic joints with the idea of thereby more easily controlling the sepsis is in our experience usually unsuccessful in its aim and disastrous in its results as to future function. The knee joint under certain circumstances may prove an exception to this statement.

After-treatment.

The after-treatment of these joint injuries has as its keynote function. There is a fairly general consensus of opinion forming that active voluntary attempts at motion bring about the most satisfactory results. Massage is of greatest help, electro and hydrotherapy are important, but upon active mechanotherapy and especially upon curative occupational therapy we can most surely rely for functional return of motion and strength.

We must keep constantly in mind, moreover, that those joints which are destined to become partially or completely ankylosed must be retained in positions favorable to future function. This is of utmost importance.

A shoulder should be fixed in from 50 to 80 degrees of abduction, an elbow in from 70 to 110 degrees of flexion, a wrist in slight dorsiflexion, a hand in slight supination, a hip in slight flexion, slight abduction and slight outward rotation, a knee in 10 to 30 degrees of flexion, an ankle at about the right angle with the leg. The variations from a single standard depend upon future occupation. There is no variation in the general principle.

Brisement forcé we deprecate almost without qualification when employed as a method to obtain motion. We admit that there are cases in which it is successful, but in old joints which have been septic we believe it is dangerous, unscientific, and usually unsuccessful.

Arthroplasty.

In the elbow and occasionally in the hip arthroplasty may succeed. Some form of absorbable membrane is probably better than pedunculated flaps as interposing substance. We have looked for justifying results in the shoulder and knee but we have not found them. We have attempted to gain them but have not succeeded.

Rare instances we have seen and experienced, but to one success there are ten failures and the first duty of the surgeon is still to do no harm.

A flattering success at the end of six months is usually flat failure in a year.

Summary.

The essentials in the treatment of gunshot injuries of joints seem to us to be the following, given in the order of their importance.

1. Fixation and traction provided at the earliest possible moment by thoroughly efficient splints and continued in transport till a hospital is reached, at which the patient may remain until convalescence from a possible operation is sufficiently well advanced to allow safe further transport (in all probability two or three weeks).

2. Early careful examination, radiographic, bacteriological, and clinical, at the earliest possible moment after the injury. This examination must be carried out by a specially trained surgeon capable of operating skillfully and at once, and at a well-equipped hospital, not far from the line, where the patient may remain under the close observation of this surgeon or his qualified assistants until convalescence is well established.

3. Primary, delayed primary, or secondary closure of the wound in all operative cases by a special technique now sufficiently well established to be regularly followed, which in the secondary closures involves a thorough knowledge of the Carrel-Dakin method.

4. After-treatment to assure most perfect function, consisting of early active motion. Later massage, possibly electrical and hydrotherapeutic treatment, often in conjunction with special orthopedic apparatus, and curative occupational therapy.

Orthopaedic Society Meeting.

SECTION IN ORTHOPEDIC SURGERY.

New York Academy of Medicine, 17-21 West 43rd Street. Clinical Meeting in Charge of the Hospital for Deformities and Joint Diseases. Friday Evening, April 18, 1919, at 8.30 O'clock, Sharp.

ORDER

I. Reading of the Minutes.

II. Presentation of Patients.

a. 1. Slides and x-ray demonstrations of interesting cases. Joseph Roth, M.D.

b. 1. Multiple bone cysts of os calcis; 2. Abscess of upper end of tibia; 3. Hemorrhagic osteomyelitis of wrist; 4. Fibro-sarcoma of wrist. Harry Finkelstein, M.D.

c. 1. Hysterical paralysis with lateral curvature; 2. Paralysis of both legs following influenza. Charles Rosenbeck, M.D.

d. 1. Poliomyelitis of forearm with return of muscle function after fifty years. Florence V. Ralston, M.D.

e. 1. Focal infection of frontal sinus (blindness and arthritis); operation with cure. Harry Rodman, M.D.

f. 1. Rectal abscess with symptoms of sacro-iliac and sciatica for which patient was treated; relief by operation. Harry Goldman, M.D.

g. 1. Mediastinal tumor with paresis of left arm. Ignac Neumann, M.D.

h. 1. Fracture of ten years' duration; Lane plate in place; 2. Un-united fractures (2 cases); operation with cure; 3. Cervical rib pressure paralysis; operation with relief of pressure paralysis. Philip M. Grausman, M.D.

i. 1. Intra-uterine fractures. Albert L. Levy, M.D.

j. 1. Intra-uterine amputation. Samuel A. Jahss, M.D.

k. 1. Amputations and artificial limbs. David H. Levy, M.D.

l. 1. Comminuted fracture of elbow (2 cases). Max Strunsky, M.D.

m. 1. Dressing for fractured clavicle; 2. Dislocation of epiphyseal end of radius. Herman C. Frauenthal, M.D.

n. 1. Arthritis cured by typhoid injections. Maurice Packard, M.D.

o. 1. New method of treating detached semilunar cartilages; 2. New method of treating fractured olecranon; 3. New method of treating congenital dislocation of the hip; 4. Interesting cases of obliterating endarteritis. Henry W. Frauenthal, M.D.

III. Discussion.

Reginald H. Sayre, M.D., *Chairman*, 14 West 48th Street

George Barrie, M.D., *Secretary*, 15 East 48th Street

Book Review

Treatment of War Wounds by the Method of Mencière. Creignou, Médicin Major de 1re Classe des Troupes Coloniales, and G. Blaque, Licenciés-Sciences, Lauréat de l'Ecole Supérieure de Pharmacie de Paris. Paris: 1918. Librairie J. P. Baillière et Fils.

It is no longer necessary to eulogize the method instituted by Mencière for the treatment of infected wounds. The proofs of its efficacy accumulate and the method becomes more widespread from day to day. It unites usefulness and simplicity.

The book, which is intended as a *vade-mecum* for those availing themselves of the method, treats the subject under the following headings: General considerations of the Mencière method: The active principles of dressing of wounds; Formulas: (*a*) solution, (*b*) emulsion, (*c*) water, (*d*) pomade; Material necessary for the application of the method; Technique of the dressing: (*a*) routine application of the balm, (*b*) delayed application of the balm; Application at the front line and at evacuation stations; Bacteriologic and cytologic control.

Current Orthopaedic Literature

Numerals at head of each abstract are for use in connection with the official "Classification of Orthopædic Literature," published in the JOURNAL for January, 1917, reprints of which are obtainable from the JOURNAL office.

III. ORTHOPEDIC OPERATIVE, POST OPERATIVE, AND ADJUVANT TECHNIC.

III, 7, c.

THE POSITION OF THE OPERATION FOR THE EXCISION OF A CARTILAGE IN MILITARY SURGERY. T. E. Hammond, M.D. *British Medical Journal*, Dec. 28, 1918.

This paper is a very interesting one. His statistics were gotten up at the request of General Sir Robert Jones, upon operations performed at Alder Hey Military Orthopædic Hospital for damaged semilunar cartilages of the knee joint. The total number of cases admitted with the diagnosis of misplaced cartilage to the end of 1917 was 283. The total number of cases operated upon for the excision of a cartilage or a synovial fringe was 112. In many of the remaining 171 cases nothing abnormal could be found, while in others only slight wasting of the quadriceps was observed. In 20 cases definite osteoarthritis was present; in 7, tuberculous disease; in 4, villous synovitis; and in 1 sarcoma at the lower end of the femur. Of the 112 cases operated upon, 8 were discharged as fit for general service immediately; 99 were discharged to a command depot as fit for general service within four months; five were discharged as fit for home service only. The average stay in hospital before operation was 22 days, and varied from 3 to 50 days. The average stay in hospital after operation was 85 days, and varied from 21 to 135 days.

In order that the final category of officers and men discharged for general service in four months should be known, a request was sent to Records for their posting after discharge with the present category. Replies were received in 36 cases.

	Number	Percentage
Class A (General Service)	19	53
Class B (Garrison Duty)	8	22
Class C (Home Service)	5	15
Class P (Reserve)	2	5
Unfit for further military service	2	5

Five of the Class A men had been killed in action.

For comparison a similar proceeding was carried out in cases in which nothing abnormal was found with the knee, and the soldier was discharged to a command depot as fit for general service in four months. Replies were received in 27 cases.

	Number	Percentage
Class A	9	33
Class B	4	15
Class C	5	19
Class P	6	22
Unfit for further military service	3	11

From a purely military aspect an operation of choice is only justifiable if it raises the soldier's category, or relieves him of a condition the persistence of which would be harmful. It is dangerous for a soldier, liable to recurrent dislocation, to be placed in the firing line (Class A). The highest category in which he should be put is B (Garrison duty), and then only if recurrence is infrequent; otherwise arthritis may arise.

Internal derangement of the knee in the intervening stage is easily simulated. In a doubtful case the conscientious medical officer will often give the patient the benefit of the doubt, since he realizes the risk of sending the genuine case back into the firing line, and knows that subjective symptoms without definite physical signs are not uncommon. Were all such cases to be returned to the firing line a grave injustice would be done to the genuine case. On the other hand were all the cases to be placed in Class B malingering would certainly increase.

Full movement of the knee after an operation is usually regained in three weeks, and graduated exercises should then be started. There would be no necessity for the cases to stay in hospital were it possible for them to be sent to a special command depot to be under the supervision of a medical officer who understands his work, and the method of developing the quadriceps by graduated and resistance exercises. The post-operative stay in hospital would thus be considerably reduced and a much larger percentage of the patients would rejoin their units in a much shorter period of time.

That only 83 per cent. of the men discharged are finally passed as fit for general service is due to lack of judgment and perhaps energy on the part of the medical officers at the command or regimental depots. During my term of office as registrar at Alder Hey on no occasion did any communication about a knee operation arrive. That the category of 47 per cent. should have been lowered without any reference to the nature of the operation indicates that far too much attention is paid to subjective symptoms. With proper supervision 95 per cent. of the cases operated upon should have been placed in Class A.—*M. S. Henderson, Rochester, Minn.*

III, 8, *b* and *c*.

A Practical Method for Making Molds of the Hands and Feet. Roederer. *Paris Médical*, Nov. 30, 1918, p. 416.

Molds of a deformed part furnish a means of record much better than descriptions or photographs. Unfortunately, however, the classical methods of molding are not applicable to the hands and feet, especially if the member have a hooked or other complicated deformity. For all such molds the following method can be used to advantage. A cylinder formed by rolling up cardboard and tying with twine is set on end on a flat surface. A little plaster paste is poured in to close it at the bottom. The hand is carefully oiled and a strong string laid along the border of it from the inner side of the wrist down around the tips of the fingers and thumb and back up along the outer side of the wrist, and held in place by wax. If the fingers are to be separated the string should follow around the sides of each finger, and if there is a *main de griffe* or other deformity, more than one string will have to be used in order to divide the plaster into as many pieces as necessary to allow the hand to be easily freed.

Plaster paste sufficient to fill the cylinder is then made and poured in. The hand, prepared as described above, is inserted into the plaster and at the precise moment when the plaster is set enough to maintain its shape, but not too hard, the string is pulled at each end, cutting the negative mold so that it falls apart. The positive mold is then obtained by fitting the negative together and filling with plaster cream which may be colored with

carmen to facilitate the removal of the white particles of the negative. For the foot the technic is varied to suit the size and shape of the member.—*William Arthur Clark, Chicago.*

XIII. ACUTE AND CHRONIC AFFECTIONS OF MUSCLES, TENDONS, AND LIGAMENTS.

XIII, 3.

A Contribution to the Study of Myositis Ossificans Progressiva. Julius Rosenstirn. *Annals of Surgery,* December, 1918.

Dr. Rosenstirn gives a continuation of a former paper in the *Annals of Surgery.* He reports a case under his own observation, including x-ray findings, microscopic pathology, and operative treatment. He takes up the condition as observed in dogs. He quotes the observations of many other investigators. The paper covers over forty printed pages and the bibliography occupies eight pages. There are many excellent illustrations showing roentgenograms and microscopic slides.

Dr. Rosenstirn's conclusions follow:

1. Myositis ossificans progressiva is a misnomer for a pathological process of atopic ossification starting primarily in the connective tissue of the exoskeleton and involves in its further progress the tissues of the endoskeleton. It would be better named fibrocellulitis ossificans progressiva. The disease nearly always commences at an early period of life and shows as additional characteristic symptoms a microdactylia of fingers and toes, and in some cases a more or less pronounced degree of infantilism.

2. Similar to the primary hemorrhage of the traumatic myositis ossificans, the introductory feature of the pathological process in the progressive form is an initial intercellular capillary hemorrhage which starts the growth of newly-formed connective tissue surrounding the hemorrhagic extravasation without any previous hypertrophy of the adjacent connective tissue.

3. Calcification and ossification take place at first at the newly-formed connective-tissue strands encircling the hemorrhagic mass, and with few exceptions from within outward.

4. There is an apparent active participation of the enclosed erythrocytes in the bone formation; they change their round form to a spindle-cell shape and seem to become nucleated as they approach the osteogenetic edge of the encircling ring and merge into its substance.

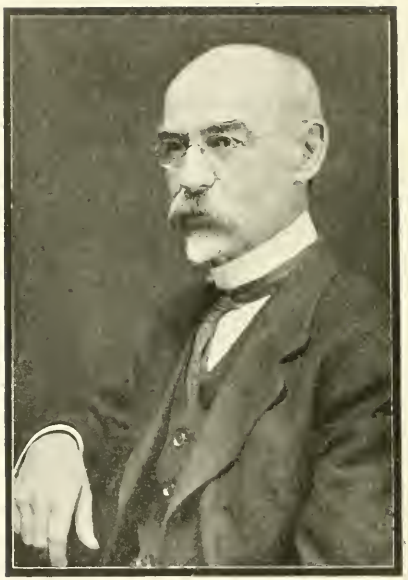
5. The microdactylia has an endogenetic origin and is the result of an "anlage" defect of the carnal and tarsal tissue rays (*gewebsstrahlen*), causing thereby an imperfect development of the last endings of the extremities in one part or other.

6. The initial hemorrhage is probably due to a similar cause affecting the integrity of the last endings of the vascular system, the capillaries, from which the hemorrhage starts.

7. The calcification and consequent ossification of the newly-formed connective tissue is due directly and indirectly to the primary hemorrhage. The hemorrhagic effusion with its calcium content starts the first deposit of lime and indirectly stimulates its continuation by a nutritive impairment of the surrounding tissue from pressure of the extravasation.

8. Investigations made under scientifically correct premises show there is no reason for believing in a diminished calcium excretion or a calcium retention in this disease.

9. No therapeutic measures against the products or the progress of the disease have proven of any value.—*Harold A. Pingree, Portland, Maine.*



H. Augustus Wilson
1853–1919

Vol. I, No. 6 JUNE, 1919 Old Series: Vol. xvii, No. 6

The Journal of Orthopædic Surgery

DR. H. AUGUSTUS WILSON.

Dr. H. Augustus Wilson, a former president of the American Orthopedic Association, died in Philadelphia on April 16, 1919, after an illness of two days.

Dr. Wilson was born in Philadelphia September 4, 1853. After a preparatory education in the public and private schools of Philadelphia, he entered Jefferson Medical College, graduating in 1879, and in 1894 Ursinus College conferred upon him the degree of A.M., for distinguished services in the cause of education. In 1885, Dr. Wilson was made Professor of Mechanical Surgery at the Philadelphia Polyclinic, a title which was later changed to Professor of General and Orthopedic Surgery. Since 1897 he has been Emeritus Professor of Orthopedic Surgery. In 1889, as Clinical Professor of Orthopedic Surgery, he delivered the first course of lectures on orthopedic surgery ever given in the Woman's Medical College. In 1904, Dr. Wilson was appointed Professor of Orthopedic Surgery in Jefferson Medical College, a position which he resigned on the thirty-ninth anniversary of his gradnation, in 1918, since which time he had been Emeritus Professor.

Dr. Wilson became a member of the American Orthopedic Association in 1891 and has always been an active worker. He has served on the Editorial Committee, the Executive Committee, and the Membership Committee, was First Vice-President in 1893 and President of the Association in 1901. He had also been made chairman of the Committee of Arrangements for the Annual Meeting of the Association which is to be held this month in Atlantic City.

Dr. Wilson will be greatly missed at the meetings of the Association, of which he had been for so many years a devoted member.

THE NON-OPERATIVE TREATMENT OF NERVE LESIONS INVOLVING THE UPPER EXTREMITY.*

BY T. E. HAMMOND, F.R.C.S., CARDIFF, WALES.

This subject will be discussed under two headings:

1. Cases in which adhesions are absent and paralysis alone exists.
2. Cases in which adhesions are present causing,
   - *a.* Limitation of flexion.
   - *b.* Limitation of extension.
   - *c.* Limitation of flexion and extension.

THE TREATMENT OF NERVE LESIONS IN WHICH ADHESIONS ARE ABSENT.

The relaxation of paralyzed muscles, a principle for which we are indebted to General Sir Robert Jones, forms the most essential part in the treatment of all nerve injuries. Unless this is properly carried out, all other forms of treatment are of diminished value. There is one position in which all muscles, ligaments, and tendons are relaxed, the position of physiological rest, which is taken up by the body when at ease.

The Position of Physiological Rest.

The upper extremity is suspended from the body by muscles and ligaments. In the upright position these muscles and ligaments support the whole weight of the arm. Any position which takes part of the weight, and so lessens the strain on the muscles, is taken up as the position of rest; the hands may be kept in the pockets, the lower margins of which support the arm; the soldier supports the arms on his rifle. When no such accessories are present, the position of ease is that shown in Fig. 1.

The forearm rests on the prominence formed by the great trochanter and its attached muscles, which takes part of the weight of the arm, and so lessens the strain on the shoulder muscles.

The elbow is flexed at 120°.

The shoulder is abducted 15° and inwardly rotated. This abduction is masked by the flexion of the elbow and the internal rotation. If the elbow be extended with the thumbs pointing forwards, the angle of abduction becomes evident.

The hands are held midway between pronation and supination to lessen the effect of gravity on the fingers. The wrist is dorsi-flexed 45°,

* A paper read before the British Orthopædic Association, July 26, 1918.

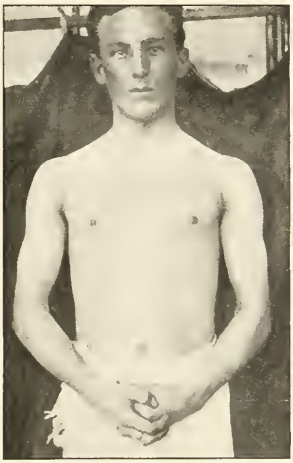


FIG. 1.—To show position of physiological rest.

FIG. 2.—To show position of hand when at rest.

with the fingers flexed 20° at the metacarpo and mid-phalangeal joints and 5° at the distal. The thumb is abducted 30° in a plane at right angles to the palm and is flexed at 20° at both the metacarpo- and inter-phalangeal joints. With the hand in this position the plane of the anterior surface of the forearm passes half an inch below the tips of the fingers, and a line continuing forwards to the radial border of the forearm passes longitudinally through the thumb (Fig. 2).

Four arches are present, the proximal and distal transverse, and the inner and outer longitudinal: The proximal arch, situated at the level of the carpo-metacarpal articulations, is formed by both rows of carpal bones and the bases of the metacarpals. It has a dorsal convexity most prominent at the junction of the third metacarpal and os magnum, and is maintained by the carpo-metacarpal and anterior annular ligaments and the tone of the thenar and hypothenar muscles. Upon this arch the force of flexion of the thumb depends. The distal arch, formed by the heads of the metacarpals, is most prominent over that of the third. It is maintained by the palmar aponeurosis and transverse metacarpal ligaments, and the tone of the interossei, lumbricals and flexors. Upon this arch depends the force of flexion of the fingers. It is continued forward to the tips of the fingers. The hollow in the centre of the palm is not an independent arch, but is formed by the thenar and hypothenar eminences.

The outer arch is formed by the thumb and outer portion of the carpus. Starting at the scaphoid, it passes forwards and laterally to the head of the metacarpal and then forwards and medially to the tip of the thumb, with the summit over the head of the metacarpal and a secondary curve over the interphalangeal joint. It is maintained by the tone of the long flexor and small muscles of the thumb and the anterior and lateral ligaments of the joints.

The inner arch, formed by the inner portion of the carpus and the four inner metacarpals and phalanges, begins at the carpal bones and passes forwards and upwards to the heads of the metacarpals, and then downwards and forwards to the tips of the fingers, with the summit over the heads of the metacarpals and secondary curves over the interphalangeal joints. It is maintained by the tone of the interossei, lumbricals, and flexors, by the palmar aponeurosis, and the anterior and lateral ligaments of the joints.

This position of physiological rest corresponds to the position of relaxation and is practically constant for the hand. Slight variations may occur at the shoulder and elbow according to the position of the point of support.

The Mechanism for Maintaining the Position of Physiological Rest.

This position is maintained by muscle tone, by which is meant a slight, continuous, involuntary contraction, dependent on a reflex arc with a centre in the cord, and afferent fibres from the ligaments and tendons, and efferent fibres to the muscles.

This tone keeps the muscle under slight tension, so that on receipt

of an impulse immediate contraction takes place. Were the muscle not under tension, delay would occur in taking up the "slack." At the same time it prevents the muscles and ligaments from being stretched and counteracts the influence of gravity.

When a position other than that of physiological rest is taken up during sleep, one group of muscles and ligaments is stretched. From the latter, stimuli pass to the centre calling for increased tone in the stretched muscles, and, when no resistance is present, the position of rest is resumed.

When a nerve is divided, the reflex arc is destroyed and muscle tone is lost. Stretching of one group of muscles and ligaments occurs owing to the unopposed tone in the opposite group, and, unless these stretched structures are relaxed, degeneration follows.

The Relaxation of Muscle.

By relaxation is meant the placing of a muscle in its normal position of rest, so that no strain is thrown upon it.

In relaxing paralyzed muscles, stretching of the opposing group must be avoided. Were slight stretching of muscles and ligaments to occur, the muscles by their elasticity would elongate considerably, so that no strain is thrown upon their attachments. The ligaments are practically inelastic, and strain at their attachments develops. Were this position to be maintained in the normal hand for some time, the stretching of the muscles would give rise to paresis, the chronic strain on the ligaments to chronic inflammation and adhesions. In nerve lesions the nutrition of the tissues is impaired, and paresis and adhesions follow the slightest strain. In the case of powerful muscles associated with the grosser movements, the paresis is of little consequence and soon disappears. In the case of the joints and muscles of the hand, where accurate and finely co-ordinated movements are essential, the slightest paresis and adhesions markedly impair its function. Therefore, not only must the paralyzed muscles and ligaments be relaxed, but at the same time it is equally essential that stretching of the opposing group does not occur.

In the position of physiological rest all muscles, tendons, and ligaments are relaxed. This is shown by the fact that it is the position taken up during ease and sleep, and that it can be maintained for a prolonged period without the slightest discomfort or fatigue. Any other position of the normal hand can only be maintained by slight voluntary contraction or passive force, and would be associated with hyper-relaxation of one group of muscles and ligaments and stretching of the opposing group.

Were the hand to be kept in the position of rest for several weeks, no discomfort would occur, and on removal of the splint full forcible contraction of the muscles could immediately take place. This shows that no strain has been placed on any structure, and can be said of no other position of the hand.

Extension of the fingers beyond this position causes an ill-defined feeling of tension over the anterior aspects of the joints, which passes into the forearm when the wrist is dorsi-flexed; this is due to stretching of the ligaments in the former and of the muscles in addition in the latter. A similar condition is present on flexing the fingers and wrist. Were the normal hand to be kept in either of these positions for several weeks, a dull aching pain would be present, and, on removal of the splint, slight paresis due to stretching of the ligaments and muscles. Hyper-relaxation of one group of muscles and ligaments has occurred, but only by stretching the opposing group.

There is consequently only one position in which paralyzed muscles can be placed without stretching the opposing group, the position of physiological rest.

It is stated that, as normal muscles are under slight tension in the position of rest, paralyzed muscles should be hyper-relaxed. This tension is present in a normal muscle, whether it is relaxed, hyper-relaxed, or stretched. This is seen when the quadriceps is divided during amputations through the thigh, retraction of the muscle occurring as soon as it is divided, whether the knee is flexed 30 (position of relaxation), fully extended (position of hyper-relaxation), or flexed to 90 (position of stretching). This tension is entirely dependent on muscle tone and disappears as soon as this is lost. Under a spinal anaesthetic the peripheral reflex arc is temporarily abolished and muscle tone is lost; in amputations through the thigh, division of the quadriceps is not now followed by retraction unless in the position of stretching.

Hyper-relaxation does not produce quicker recovery of power in paralyzed muscles than true relaxation. On the other hand, it is much more harmful, as it stretches the opposing muscles and ligaments and gives rise to paresis and adhesions. Adhesions forming after paralyzed muscles have been relaxed are due to the fact that hyper- and not true relaxation has been produced.

The Application of the Principle of Relaxation to the Hand.

In the position of rest the ligaments are slightly slack, more so on the dorsal than on the palmar aspect, and but little deviation from this position is possible without strain on their attachments. The muscles

control accurate and finely co-ordinated movements. Under no condition should the slightest stretching of these muscles and ligaments occur. The hand should always be placed in the position of physiological rest in lesions of the musculo-spiral, median, or ulnar nerves, the arches being carefully preserved in all cases.

In musculo-spiral lesions the wrist has been dorsi-flexed to 60° with the fingers almost fully extended to relax the extensors; in ulnar lesions the fingers have been flexed at 90° at the metacarpo-, and extended at the interphalangeal joints to relax the lumbricals and interossei, and in some cases the wrist is palmar flexed 45° to relax the flexors; in lesions of the median the two outer fingers have been flexed 90° at the metacarpo- and fully extended at the interphalangeal joints to relax the lumbricals, with the wrist flexed 45° to relax the flexors. In all cases hyper-relaxation of the paralyzed muscles has occurred and adhesions have formed in most cases. Such positions must, therefore, be condemned.

The Application of Relaxation in Paralysis of the Deltoid.

The shoulder in the position of rest is abducted 15°, and the humerus is maintained in contact with the glenoid by the tone of the shoulder muscles, particularly by that of the deltoid. With paralysis of the deltoid, the arm is adducted and falls away from the side, and in long standing cases there may be as much as one-fourth inch lengthening of the arm. To maintain the arm in the position of rest not only must it be abducted 15°, but at the same time the humerus must be held in contact with the glenoid. An apparatus to maintain this position would be complicated and apt to get out of order. Abduction of the arm to 80°, recommended by Sir Robert Jones, not only produces the necessary abduction, but at the same time the tone of the pectoral and upper scapular muscles keep the humerus in contact with the glenoid. In this position the deltoid is hyper-relaxed, and stretching of the opposing muscles occurs. These are powerful muscles which contract with gravity and control gross movements, consequently any paresis soon passes off. The lower margin of the capsule is exceedingly loose, and with abduction to 80° no strain is thrown on its attachments and adhesions do not form.

This position can be easily maintained by the abduction splint, introduced by Sir Robert Jones.

Methods of Maintaining the Hand in the Position of Rest.

This is carried out by splints and strapping, for the application of which a knowledge of the creases of the hand is essential.

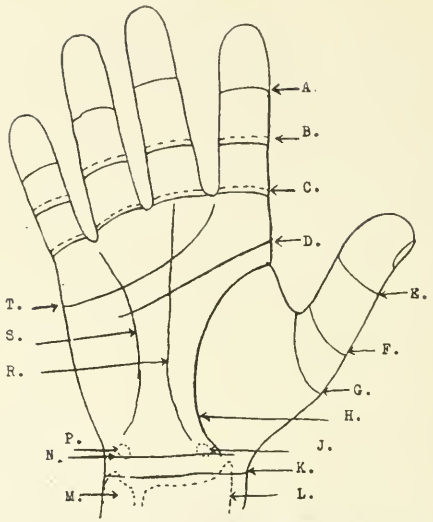


FIG. 3.—The creases of the hand. *A*, Distal digital crease; *B*, Middle digital crease; *C*, Proximal digital crease; *D*, Inner transverse crease; *E*, Distal thumb crease; *F*, Middle thumb crease; *G*, Proximal thumb crease; *H*, Thenar crease; *J*, Tubercle of scaphoid; *K*, Proximal wrist crease; *L*, Radius; *M*, Ulna; *N*, Distal wrist crease; *P*, Pisiform; *R*, Middle palmar crease; *S*, Hypothenar crease; *T*, Inner palmer crease.

a. The Creases of the Hand. On the front of the wrist two creases are present, the proximal corresponding to the level of the radio-carpal, the distal to the inter-carpal joint.

The thenar crease, commencing externally to the tubercle of the scaphoid, passes forwards and outwards to join the outer border of the hand one inch below the base of the forefinger, and corresponds to the inner border of the thenar muscles. A splint, to allow full movement of the thumb, must have its outer border internal to the thenar crease.

The transverse crease is situated over the distal portion of the palm. The outer portion commences distal to the thenar crease, and passes backwards and inwards to fade away over the hypothenar eminence. The inner begins one inch below the little finger, and passes forwards and outwards towards the cleft between the index and middle fingers. This crease corresponds to the base of the phalanges on full flexion of

the fingers. A splint to allow full flexion of the fingers should not extend beyond a line joining the outer and inner borders of this crease.

The hypothenar crease, very indistinct, commences externally to the pisiform, and passes forwards to fade away over the base of the little finger. It corresponds to the outer margin of the hypo-thenar muscles.

The middle palmar crease begins over the tubercle of the scaphoid, and passes forwards to fade away over the base of the middle finger. It corresponds to the summit of the transverse arch of the palm, and should represent the long axis of the long and short cock-up splints.

The proximal digital crease corresponds to the line of contact of the fingers and palm on full flexion and is of no importance.

The lower of the middle digital creases corresponds to the line of flexion of the proximal phalangeal joint and to the proximal secondary curve on the inner arch.

The distal digital crease corresponds to the line of flexion of the terminal phalangeal joint and to the distal secondary curve.

The proximal thumb crease corresponds to the anterior edge of the base at the first phalanx on full flexion and to the summit of the outer longitudinal arch.

The middle thumb crease is of no importance.

The distal thumb crease corresponds to the interphalangeal joint and to the secondary curve on the outer arch.

b. The Long Cock-up Splint. This consists of two pieces, one for the forearm, the other for the hand.

The forearm piece, grooved from side to side so that no pressure is exerted on the muscles, extends forwards to the distal wrist crease.

The hand piece, dorsi-flexed 45°, is firmly united to the forearm piece, the line of junction being slightly rounded to fit the wrist. There are two segments, one for the fingers, the other for the thumb.

The border of the finger piece passes forwards and inwards to the scaphoid, and then forwards and outwards, internally to the thenar crease, to reach the outer border of the hand at the same level. It now proceeds forwards, inwards, and backwards to join the inner border of the forearm piece. It should be curved in its long axis to fit the inner arch with secondary curves at the transverse and middle and distal digital creases to correspond to the normal flexion at the corresponding joints. At the level of the distal wrist crease there is a central transverse curve to fit the proximal arch with hollows on each side to take the prominences of the scaphoid and pisiform. This transverse curve is continued forwards to the tips of the fingers, the middle

FIG. 4.—To illustrate relation of short "cock-up" splint to the creases of the hand.

crease and finger forming the summit. The inner of the two hollows is continued forwards to take the hypothenar eminence, the outer being continued into the thumb piece.

The thumb piece is attached to the finger piece in the line of the thenar crease, and is abducted 30° in a plane at right angles. It should be grooved at the base to take the thenar eminence, and is curved in its long axis with the summit opposite the proximal thumb crease, and a smaller secondary curve opposite the distal crease.

If this splint were applied to a hand the muscles of which were paralyzed, the long and transverse arches would be preserved, no pressure would be present on the thenar and hypothenar eminences, and the thumb would be held in its normal position. There would be no stretching of any structure, the hand being held in the position of rest.

c. The Short Cock-up Splint. The forearm piece is not quite so long. The hand piece is dorsi-flexed 45°. The outer border of the hand piece passes forwards and inwards externally to the tubercle

Fig. 5.—To show splint *in situ*

Fig. 6.—To illustrate full flexion of the fingers.

of the scaphoid to reach the thenar crease. It then passes forwards internally to this crease in the direction of the cleft between the fore and middle fingers, but just proximal to the transverse crease turns inwards. Reaching the hypothenar crease, it passes backwards externally to this crease until the base of the hypothenar eminence is reached, when it passes obliquely inwards to become continuous with the forearm piece.

There should be a dorsal convexity to fit the proximal arch, with a small hollow on each side to take the tubercle of the scaphoid and the pisiform.

This splint allows full flexion of the fingers and thumb, supports the arches of the hand, and no pressure is exerted on the thenar and hypothenar muscles (Figs. 4, 5, 6).

When fibrous adhesions are present in the wrist joint, a slightly wider splint is advisable.

d. The Application of Strapping. To maintain the distal arch the strapping should be applied on a level with the transverse crease, the hand being in the position of physiological rest with the arch re-formed.

In the case of the proximal arch it crosses the first metacarpal at

the junction of the middle and lower thirds and the inner border of the hand just above the pisiform, the thumb being abducted 30° and the proximal arch well formed.

The Application of These Methods to the Individual Nerve Lesions.

In lesions of the musculo-spiral, drop-wrist with slight flexion of the fingers is present. The hand should be placed on a long cock-up splint with the long and transverse arches carefully preserved.

In lesions of the ulnar, the fingers are hyper-extended at the meta-carpo- and slightly flexed at the inter-phalangeal joints. Marked flattening of the distal arch is present. The hand should be placed in the position of rest with the transverse arch well formed. As a rule strapping to support this arch and a small cock-up splint are alone required.

In lesions of the median the two outer fingers are held extended with the thumb extended and adducted. The proximal and, in many cases, the distal transverse arches are flattened. Strapping to support both arches and a small cock-up splint must be applied to maintain the position of rest. When the nerve is divided below the branches to the flexors, support of the proximal arch is alone required.

The Special Forms of Treatment.

The object is to increase the circulation, to improve the nutrition, and to prevent the formation of adhesions. Marked vasomotor changes are present, the hand being cold and blue with a very poor circulation. A similar condition exists in the underlying muscles.

It is most beneficial to obtain a good circulation in the limb before the application of massage. Voluntary exercise by its general effect and heat by its local effect both accomplish this. In all nerve lesions of the upper limb a daily gymnastic course is advisable, unless there is some contra-indication such as active inflammation. Heat is best applied by the whirlpool bath.

Throughout treatment it is essential that the paralyzed muscles are held relaxed.

During massage passive movements of the fingers should be carried out with the greatest care to prevent stretching of the paralyzed muscles. Returning voluntary power is encouraged, and is carried out with the help of and not against gravity. Muscles which are recovering function are easily tired. As soon as the contraction shows signs of diminishing, the muscle should be immediately relaxed and massaged. Voluntary contraction of the other muscles should be encouraged provided the paralyzed muscles are not stretched.

With electrical treatment the nature of the current employed de-

pends upon the reaction of the muscle. If the whole muscle reacts to faradism, then this current alone is employed. If part only of the muscle reacts to faradism, the galvanic and faradic currents must be applied. If no reaction to faradism is present, the galvanic current only is applied. If there is no reaction to galvanism, electrical treatment is useless. A healthy muscle, made to contract repeatedly by a current, soon begins to show fatigue, a paralyzed muscle much sooner. Much harm may be done to a muscle, if it be stimulated after the onset of fatigue. As soon as the contraction to a given current begins to diminish, the current should not be increased; electrical treatment should be stopped and massage substituted.

It is advisable that massage, whirlpool bath, and electrical treatment should not be given separately for a definite period, but that they should be combined.

The curative workshops form a valuable adjunct to all other forms of treatment.

THE TREATMENT OF NERVE LESIONS WHEN ADHESIONS ARE PRESENT.

The Cause of the Formation of Adhesions.

Muscle paralysis and vasomotor changes predispose to but are not the actual cause of the formation of adhesions. This is shown by the complete absence of adhesions in many cases of complete nerve division. The real cause, apart from the direct involvement of tendons in scar tissue, appears to be the stretching of ligaments.

Ligaments possess afferent fibres which pass to the centre in the cord, and receive efferent fibres from the sympathetic system. When ligaments are stretched, chronic strain arises at the attachments; this gives rise to chronic reflex vasomotor changes, chronic inflammation, and the formation of adhesions.

When a nerve is completely divided, all the motor, sensory, and sympathetic fibres are destroyed. Stretching of the ligaments follows the loss of muscle tone, but, as they are insensitive, no reflex changes occur, and no adhesions develop. This explains the absence of adhesions in complete nerve lesions, when no splint has been worn.

If splints are applied to produce true relaxation, no strain is thrown on any muscle or ligament and no adhesions form.

If hyper-relaxation is produced, the opposite ligaments are stretched. These are sensitive; reflex changes are set up, and adhesions form. This explains the occurrence of adhesions in many complete nerve lesions following the application of splints to produce relaxation. Hyper-relaxation and not true relaxation has been produced.

When a nerve is completely divided, the sensory fibres alone may be involved, and no loss of muscle tone occurs. No adhesions form in such cases, as no ligament is stretched. When the motor fibres are involved, there is loss of muscle tone and the ligaments are stretched. If these are still sensitive, reflex changes are set up and adhesions form. This explains the occurrence of adhesions in many cases of untreated, incomplete nerve lesions, a fact pointed out by the French neurologists.

In the painful neuritic forms these vasomotor changes arise as the result of direct stimulation of the nerve. Hence the formation of adhesions in such cases, even if true relaxation is produced.

Principles Involved in the Treatment.

In all cases, except the painful neuritic forms, the formation of adhesions could be prevented by properly relaxing the paralyzed muscles and ligaments.

When present, the first consideration must be devoted to assist their absorption and to make the hand supple. At the same time treatment of the paralyzed muscles must not be neglected.

Three methods are available:

1. The encouragement of voluntary movement with the application of very slight force.
2. The application of moderate force.
3. The application of great force, the adhesions being broken down under gas.

As a rule, the nutrition of the involved structures is much impaired and marked vasomotor changes are present. Consequently the application of force is often followed by much swelling, oedema, and tenderness of the fingers. Similar changes must have occurred in the joints, and it is difficult to believe that much good could follow so marked a reaction. It is therefore advised that all cases should be first treated by a prolonged course of the first method.

The Treatment When Limitation of Flexion Alone is Present.

Limitation of flexion in musculo-spiral lesions is due to adhesions at the metacarpo-phalangeal joints, in ulnar and median lesions to adhesions around the joints and tendons. In the majority of cases the distal transverse arch is flattened.

In musculo-spiral lesions, full flexion of the fingers should be obtained by contraction of the flexor muscles; in ulnar lesions, full flexion, except perhaps in the little finger, by contraction of the median flexors; in median lesions, the ulnar muscles exert but little influence on the

thumb and two outer fingers, and in such cases more force is necessary.

The power of flexion of the fingers and thumb in the normal hand is greatest with the wrist dorsiflexed 45°.

The power of flexion of the fingers depends upon the maintenance of the distal arch, of the thumb upon the proximal arch. Flattening of the distal arch in the normal hand markedly impairs the power of flexion of the fingers. If strapping be applied to reconstruct this arch when adhesions are present, the patient states that he has much more power over the fingers, and that there is a feeling of tension over the dorsum of the joints, indicating that the flexors are now exerting much more power.

In treatment of these cases, the wrist must be dorsiflexed 45°, and the arches must be reconstructed.

a. Treatment by the Application of Slight Force. During the day the short cock-up splint is worn and the arches are supported by strapping.

In the massage department, after the application of the whirlpool bath, voluntary movement is encouraged with the wrist dorsi-flexed and the arches supported. Each joint is treated separately. In the case of the metacarpo-phalangeal joint the neck of the metacarpal should be supported while the flexor is contracting, as this allows much more power to be exerted at this joint. Were it not done, much of the force would be transmitted to the carpo-metacarpal joint. In the case of the phalangeal joints, the neck of the proximal bone is supported. As soon as the muscles show signs of fatigue they are massaged and electrical treatment substituted. Each joint is again treated separately and supported as in the case of voluntary movement. The treatment is then repeated, and the masseuse may on one occasion only apply the slightest passive force.

Success depends upon dorsi-flexing the wrist, reconstructing the arches, treating each joint separately, and making full use of voluntary power.

b. Treatment by the Application of Moderate Force. By moderate force is meant a gradually increasing pressure, so that the adhesions are stretched; it should be carried out once only in each direction. Apart from the fact that the firmer the adhesions the greater the force required, no rule can be laid down as to the amount of force to be applied. It should never be carried out if any signs of active inflammation are present, nor until the first method has been given a fair trial.

After the application of massage and the whirlpool bath the bones above and below the joint to be manipulated are held between the

thumb and finger of each hand, and as much pressure as the patient can bear is applied. This may be carried out every other day, but not if any signs of reaction are present. Treatment by the first method is employed in the intervals.

The method of dorsi-flexing the wrist and flexing all the fingers together is not recommended. There is little control over the individual joints, and, since the adhesions in all the fingers may not be of the same strength, each may require a different degree of pressure.

With adhesions present in all four fingers, the pressure applied to each should vary in force, duration, and frequency; any marked improvement occurring in one would give a clue to future treatment.

Should marked reaction follow this method, or no improvement occur, then some apparatus to exert gradual tension on the ligaments should be employed.

c. Treatment by the Application of Great Force. This is not recommended, a better functional result following the first two methods.

The Treatment When Limitation of Extension Alone is Present.

These cases usually result from contraction of the tendons or from peri-articular adhesions.

The object of treatment is to elongate the contracted structures so that the hand can be placed on a full cock-up splint with the wrist dorsi-flexed and the fingers extended.

With the fingers and thumb in a given position, the distance between the points of origin and insertion of the flexor tendons is greatest with the elbow extended and the forearm supinated, and least with the elbow flexed and the forearm pronated. In slight contraction of the flexor tendons, with very slight force the fingers can often be fully extended with the elbow flexed and the forearm pronated; with the elbow extended and the forearm fully supinated this will be impossible.

The method of gradual extension, recommended by General Sir Robert Jones for ischaemic contractures, is carried out and is not stopped until the hand can be placed on a full cock-up splint with the elbow extended and the forearm supinated. It is essential that during treatment the arches of the hand should not be flattened. If the condition is due to contracture of the flexor tendon alone, great care must be taken that during treatment full extension of the phalangeal joints does not occur; if due to contractures of the ligaments then it may be necessary to extend to the full articular limits. Limitation of flexion occurring during treatment is due to the arches being flattened, or full or even hyperextension at the finger joints being produced.

The splint must be removed each day to allow the application of massage, etc., to the involved structures. The splint should not be left off until all tendency to the recurrence of the contraction has been absent for six weeks, and even then should be worn at night for a further six months.

Treatment by forcible wrenching, with or without tenotomy, is not recommended, the functional result being invariably bad.

TREATMENT OF ADHESIONS WHEN LIMITATION OF FLEXION AND EXTENSION ARE BOTH PRESENT.

This consists of a combination of the previous methods, treatment of one condition to the neglect of the other being avoided.

STIFF FINGERS: WITH SPECIAL REFERENCE TO METHODS OF TREATMENT BY METAL AND PLASTER SPLINTS.*

BY P. JENNER VERRALL, M.B., B.C., F.R.C.S., LONDON.

ALTHOUGH the methods of treatment advocated in this article are applicable to the injuries occurring in time of peace, the immense frequency with which stiff fingers are caused by gun shot wounds, has provided a mass of clinical material on which my experience is based. I do not propose to consider the treatment of recent wounds of the forearm and hand or methods by which stiff fingers may be prevented, but shall confine my attention to cases in which all wounds are healed, such as arrive for treatment at an Orthopaedic Centre.

Apart from direct wounds and septic infection of the hand, stiffness of the fingers may, of course, result from wounds of the forearm involving tendons, wounds of the nerves, prolonged immobilization in splints, or disuse following functional paralysis or other causes. Putting aside the treatment of the primary cause in these cases, I propose to treat the incomplete function of the fingers as a purely mechanical problem.

* A paper read before the British Orthopaedic Association, July 26, 1918.

On these lines the causes may be placed in two classes, (*a*) Loss of extension, (*b*) Loss of flexion; though naturally there may be limitation of both functions. Treatment, however, should, on the lines I shall indicate, be mainly directed to either one or the other at any one time.

(*a*) Loss of the extensor function is commonly due to:

1. Contracture of muscle, traumatic, ischaemic or postural.
2. Adhesion of tendons to skin or other structures.
3. Peri—or intra—articular adhesions.
4. Nerve lesions of ulnar or median nerves.

The finger deformities associated with lesions of the median and ulnar nerves are well known, consisting typically of hyper-extension at the metacarpo-phalangeal joint and flexion at the distal joints. These deformities are very common in ulnar lesions, but occur in precisely similar fashion, but to a less extent, in median lesions, in the corresponding fingers. It may not, however, be quite so well recognized that these deformities are more marked in lesions of the respective nerves in the forearm below the nerve supply to the forearm muscles, than in lesions higher up.

I take the opportunity of tentatively suggesting that this may be due to the action of the respective part of the flexor profundus digitorum uncorrected by the intrinsic muscles of the hand, especially the lumbricales.

5. Loss of the flexor function similarly may be due to: (1) Involvement of extensor tendons in scar or callus, especially in wounds of the metacarpal region. (2) Adhesion of flexor tendons to skin or deep structures by scar. (3) Peri—or intra—articular adhesions. (4) Traumatic or postural contracture of muscles.

In brief, the fingers may have lost their free movement from fixation either of their joints or of the tendons which control them.

Tendons which are tightly bound down by scar tissue should be freed by operation and removal of the scar tissue; those which are adherent to skin only may be successfully treated by massage, or by excision of the scar if this fails or is tedious.

If tendons are short, a very determined effort should, of course, be made to stretch them before the advisability of lengthening them be considered, as in this event the muscle function is impaired by the resulting contracture of the muscle belly.

A few more words may be said on the subject of tendon-grafts in the hand. Grafts are not commonly successful on the flexor aspect of the hand, but it is quite otherwise with the dorsum. Cases are often

seen of extensive scars of the dorsum of the hand with destruction of extensor tendons, and perhaps metacarpal fractures. No mechanical treatment is of any avail until these tendons are potentially mobile.

A method from which success is frequently obtained is: Firstly to excise the scar, bringing skin together and ignoring the tendons. When the wound is healed, gentle massage prevents adhesion of the cicatrix to the deeper structures. At a second operation a piece of ilio-tibial band is removed and cut into strips about 5 m.m. wide in a longitudinal direction, the longitudinal fibres of this fascia making it especially suitable. These strips are applied as grafts to fill up the gaps in the tendons, being fixed by thread sutures. It is better to make the graft overlap the sound tendon well at either end and to suture it firmly, as thus movement may be begun at an earlier period and adhesion of the graft prevented. After 6 weeks more forcible measures may be taken to increase movement.

It will be convenient to take a few types of "stiff fingers" to illustrate the methods advocated.

A. Fingers flexed when wrist is dorsiflexed; extension possible with wrist flexed.

This, the type of ischaemic contraction, due to shortening of the flexor tendons, cannot be better treated than by the method of Major-General Sir R. Jones, which consists in straightening the joints seriatim on splints applied to the flexor aspect, beginning with the distal, leaving each joint in the deformed position until all the joints distal to it are corrected, and retaining that correction by continuing splinting. Care must, however, be used lest one overlook constriction or involvement of one or more tendons in scar, as in this case, unless the tendon be freed from scar by operation, an apparent cure by the above method will be followed by a speedy relapse.

B. Wrist movement free: One or more fingers flexed at all three joints—contraction unaffected by position of wrist.

This condition is most typically seen as an after result of the so-called "fist plaster," in which, under an anesthetic, the fingers are forcibly flexed as far as possible, and the whole hand (previously covered with felt) enclosed in plaster. The fist plaster is a valuable method of treatment for obstinate cases, but it often has the disadvantage of converting a fixed extended hand into a fixed flexed one, though the latter is naturally the better, if one has only a choice of evils.

In treating a case of this type, one should aim at obtaining extension without losing flexion. If the flexion is complete, that is to say, the

patient is able to touch the palm with the tips of the fingers, so much the better, but, in any case, the degree of flexion should not be lost; any loss being an indication that treatment is too rapid.

For this purpose I have devised a metal splint, which is applied to the dorsal surface of the hand and forearm by plaster of Paris. The splint consists of a bar of iron ½ inch wide and ⅛ inch thick, which terminates distally in a triangular loop, the whole splint being about 16 inches long, and the terminal transverse bar of the triangle 4 inches in length.

To the proximal end of the splint is fixed a strip of thin metal, 1 inch wide (perforated to ensure adhesion to the plaster) which encircles half the circumference of the forearm.

The axial bar is curved at the wrist to follow the curve of the partially dorsiflexed wrist and a small plate is fixed to it to rest on the back of the hand and prevent rotation of the splint.

Fig. 1.—Finger extension splint. Treatment nearly complete.

The terminal triangle is curved slightly toward the palmar surface, so that the transverse bar is situated 2 inches beyond the point that the fingers would reach if fully extended. If this bar be too much towards the dorsum, there is danger of producing hyper-extension at the metacarpo-phalangeal joints.

The hand and forearm are encased in felt, the thumb protruding through a hole in the felt, the splint applied, and plaster applied enclosing limb and splint down to the level of the neck of the metacarpals.

The plaster must not reach below this point on the palm, as otherwise flexion of the fingers would be obstructed. After the application of the splint 24 hours are allowed for the plaster to set hard.

Adhesive plaster is then applied so as to enclose the two distal phalanges of each finger and leave a loop at the end of the finger. This is best done by cutting the plaster as in diagram.

Tapes are passed through the loops, tied to the transverse bar of the triangle, and progressively tightened as extension improves. Every day the tapes are untied, the fingers flexed to their original position several times, actively and passively, and the tapes retied. This latter is an essential part of the treatment, and is best carried out in a massage department. The force exerted by this method is surprising, very little discomfort is caused to the patient, and the only point that needs attention is the preservation of the flexion. Should extension be obtained at the price of a loss of flexion, the tapes are tied less tightly, or even relaxed for a day or two till flexion returns.

C. Free movement at the metacarpo-phalangeal joints: two distal joints flexed.

This is typically seen in ulnar (or, more rarely, median) paralysis. For the treatment of this condition small palmer gutter splints to the fingers are usually sufficient, but occasionally extreme contractures are seen, which can well be treated by the dorsal extension splint described above.

D. Metacarpo-phalangeal joints stiff in hyperextension; distal joints straight or slightly flexed.

A very common type, which may result from most of the causes mentioned above. I have already described the preliminary treatment of this type, comprising excision of scars, freeing of tendons, tendon grafting, etc.

The important underlying principle in the treatment of this type consists in getting the metacarpo-phalangeal joints to pass the dead-point or straight line position. Once there is a slight degree of flexion

at these joints further progress is much more rapid. In order to pass this point one may use a fist plaster, and this is sound treatment.

Personally I prefer a more gradual method, which can be effected by the use of the splint, which I shall now describe. Probably every orthopaedic surgeon is acquainted with the short cock-up splint of Sir Robert Jones. It consists of a metal gutter splint reaching along the flexor aspect of the lower half of the forearm, curving upwards on the palm, being flattened out and holding the wrist in dorsiflexion.

To one of these splints (cut short so as not to reach beyond the metacarpal necks and narrow in the palm, so as to allow some degree of movement between the metacarpals) is fixed a quadrilateral loop of stiff wire. This loop springs from the palmar surface of the splint at its angle and leaves the forearm portion at approximately the same angle as the palmar part of the splint. The loop reaches a point slightly beyond the level of the metacarpo-phalangeal joints and is furnished with an additional cross-bar near its point of attachment to the main splint. The splint is applied with plaster of Paris over

Fig. 2.—Finger flexion splint applied.

felt, care is taken to free the heads of the metacarpals, and extension tapes are fixed as for the splint described above. Traction is then made, first to the extremity of the loop, whereby the metacarpo-phalangeal joints are flexed, and later to the cross-bar, whereby these joints are further flexed, and the inter-phalangeal joints also treated. As before, daily untying of the tapes and massage ensures preservation of the range of movement.

When the dead point is well passed, a good method of treatment, evolved from the suggestion of Dr. Mennell (in charge of the Massage Department at Shepherd's Bush), is to utilize a plaster splint moulded to the dorsum of the hand, and distal half of the forearm, reaching only to the proximal interphalangeal joints, holding the fingers in the extreme degree of flexion obtained and leaving the two distal phalanges free. By placing successive layers of felt between the splint and the first phalanges flexion is increased, massage being continued meanwhile. A series of these splints will complete the passive corrective treatment.

Having by these means obtained a fair degree of passive movement and some active movement, the patient should then receive treatment in a gymnasium. Lieutenant Eggleton (in charge of the gymnasium at Shepherd's Bush) has a system of graduated grips and finger training apparatus which gives excellent results.

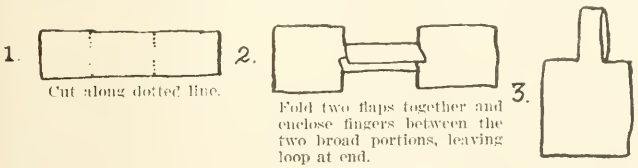
Finally, employment of the hand in a workshop, preferably at the patient's own trade, provides the best training for functional utility of the hand. Such curative workshops are in existence at Shepherd's Bush and most other orthopaedic centres.

The principal advantages claimed for the above methods of treatment by metal splints are:

1. The power, that it is possible to exert, is very great, but, at the same time, can be graduated to a nicety.

2. The correction is gradual and continuous and consequently causes little or no pain and discomfort to the patient.

3. Movement of the fingers is continued without removal of the splint and the range of movement is never lost. This is the most



Cut along dotted line.

Fold two flaps together and enclose fingers between the two broad portions, leaving loop at end.

important point of all, the daily massage and movement being an absolutely essential part of the treatment.

4. The splints, being applied with plaster, do not tend to slip off, as do other splints, when any degree of traction is applied to the fingers.

5. Each finger is treated separately, and therefore the fingers may be at different stages of treatment at one time on the same splint.

Once I did consider using elastic traction. I don't know whether you read the article on supination plaster, but it was after that I started using, by means of a rubber tube, continuous elastic traction. Sir Robert Jones pointed out to me and quite rightly, that if you are using elastic traction you are inviting the muscles all the time to fight against it, and if you work it by a system of jerks, pulling a little each day, you are not asking the muscles to be perpetually fighting. At first I used elastic traction for both these methods, but I have now given it up.

DISCUSSION

THE PRESIDENT: These papers are full of important and instructive details, and the discussion on both of them is now open.

CAPTAIN MCCRAE AITKEN: Everyone is wanting to get away, but I do not think it would be fair to the authors, nor to these important papers, for no word to be said about them.

With regard to Mr. Verrall's paper, all I have to say is, that the splints which he has introduced have become part of the regular routine treatment, I think, by every surgeon at the Military Orthopaedic Hospital, Shepherd's Bush. He referred to the plasters for forcible flexion of the fingers, a method of procedure which, at one time, I used very freely. I found exactly the difficulty that he has found: that a finger forcibly flexed and kept flexed, remained flexed. I now hold to the method of treatment which he has introduced.

The paper by Mr. Hammond is an entirely different matter. I think there is reason to regret that Mr. Hammond has loaded an important point such as that which he has brought forward by putting in such a wealth of detail. That makes a paper read before such a society as this—unless one knows about it beforehand—difficult to follow. For my part, I intend to carefully read the paper when it is published, so as to dig out from it the very important essential facts it contains. I think it is the first reasoned proper description of the hand and the position of its various joints, which I have encountered, and I believe that in the time to come it will stand as one of the classics, which nobody reads, but the essence will pass into our text-books, and become part of the ordinary descriptive work for the correction of hand deformities.

CAPTAIN PLATT: Mr. Hammond's paper, as Captain Aitken has already said, is full of important details, and a very important conclusion is drawn, which perhaps has not been sufficiently realized by the meeting,—namely, the importance of this attitude which he named the attitude of physiological rest in the hand, and of maintaining this attitude practically as a routine standard position in the treatment of nerve injuries, not merely of musculo-spiral injuries, but median and ulnar nerve injuries. And I think some of us, for some time, have been unconsciously arriving at the use of that position without exactly knowing why. Mr. Hammond's description of the arches of the hand is one of exceeding importance; it is one which should be read by everybody. It

is rather a pity that Mr. Hammond had not here some of his models and splints in order to illustrate and drive home more effectively his points. Personally, I feel exceedingly interested in his paper, and I have enjoyed it very much.

Mr. Bennett: I, also, thank Mr. Hammond for his excellent paper, because it insists on the importance of posture, not only of the hand, and I never heard a paper which impressed me more with regard to the postural treatment of diseased conditions, and of abnormalities resulting from injury.

Mr. Hammond: I wish to thank all who have spoken so kindly.

Mr. Verrall: I should like to say the same for myself.

AN OPERATION FOR THE PERMANENT CORRECTION OF WEAK FEET IN CHILDREN.

BY CHARLES OGILVY, B.A., M.D., F.A.C.S., NEW YORK CITY.

The particular type of weak feet for which this operation is specially recommended is that in which there has been present from the beginning an abnormal eversion of the foot with the associated change in the relationship of the foot to the leg. This change of relationship brings the body-weight bearing strain through the inner border of the foot. The body-weight is not directed as it should be through the ankle and over the dorsum of the foot to the second toe. In taking the history of such cases we usually find that they are hereditary.

MECHANICAL METHODS OF CORRECTION.

This correction is aimed at the maintenance of the proper relationship of the foot to the leg. This is accomplished by inverting the foot and maintaining this inversion. Inversion is obtained by means of raising the inner border of the heel of the shoe or raising the inner border of both heel and sole of the shoe.

In addition to the alterations on the shoe many employ some form of insert inside the shoe, such as a metal plate, to obtain the same end. The term "arch support" should be entirely discarded. Our object is not to "support" the arch, but it is to so control the position of the foot as to hold it in its proper relationship to the leg.

What results do we obtain by the employment of such means in these cases to which we have referred?

The answer is that after this treatment has been carried out for several years we find (1) the foot iself has not suffered from foot strain; (2) that the long arch of the foot is perfectly normal with the exception of the astragalo navicular articulation; (3) that the patient when

FIG. 1.—B. G., age 4 years Case of hereditary weak feet.

FIG. 2.—A. M., age 14 years. Weak feet.

FIG. 3. A. M. Same case Post-operative. Seen one year later without any sign of relapse.

FIG. 3*a*.—Same case one year after operation.

Fig. 4.—G. Q., age 11 yrs. Before operation.

Fig. 5.—G. Q. Five years after operation.

walking maintains the correct relationship of the foot to the leg as long as the artificial means of correction are being worn, but (4) *when these corrected shoes are removed and the patient bears his body weight upon his feet it will be seen that the abnormal eversion originally present still persists.*

After studying these cases for a number of years and failing to obtain a permanent correction by all mechanical means available, I determined to operate upon these children. Relapses constantly occurred after the artificial means of correction had been removed, notwithstanding the fact that these were continued for upward of four to five years.

Upon examination it is found that at this age (from eight to fifteen) the point of greatest relaxity is at the astragalo navicular articulation. Here we have a more or less ball and socket joint upon which the forefoot pivots. With the toes turned outward the strain upon this joint is increased and gradually the relaxity of the joint ligaments is accentuated. Subsequently the head of the astragalus rotates downward and inward. The greatest strain is at this joint. The other parts of the foot, including the astragalo-tibial joint, are at this age practically normal.

It seemed to the writer that by arthrodesing the astragalo navicular articulation with the foot held in forced inversion, a firm fibrous union could be obtained. This being the case, it would follow that the astragalo calcanear articulation would become locked by reason of its

Fig. 6.—F. P., age 12 years. Before operation.

Fig. 7.—F. P. Six years after operation.

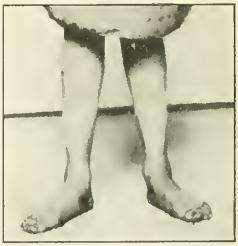


Fig. 9.—D. S. Before operation.

Fig. 8.—M. L. Six years after operation.

Fig. 10.—D. S. Same case five years after operation.

mechanical construction, and this in turn would immobilize the os calcis. The head of the astragalus, also, would by this fixation to the navicular bone be prevented from slipping downward and inward.

This altered position would prevent the transferring of the weight strain to the ligamentous structures on the inner border of the foot, namely, the interosseous and the deltoid ligaments. By this exaggerated inversion the foot relationship would be corrected under weight-bearing to its normal position directly beneath the leg.

The question at issue was whether or not an arthrodesis of the astragalo navicular articulation that would permanently hold the foot in this corrected position could be obtained at this age. Arthrodesing of this joint is by no means a new procedure, but its application by the following method for this purpose, at this age, has not been generally practised. The first of these operations was performed on October 10, 1912, over six years ago, so that sufficient time has now elapsed to judge of the value of this procedure. The writer has performed this operation over seventy times.

FAILURES.

Failure to obtain a satisfactory result has been experienced in six cases. These were among the earlier operations performed. In two of these cases a secondary operation disclosed a reproduction of a perfectly normal joint, from a macroscopical examination of which it would have been impossible to have known that there had been any previous operation.

One of the reasons why we were unsuccessful in obtaining results in these cases was due to the fact that these were in younger children, ages five to seven years. Another reason of failure was that weight-bearing strain was permitted too soon after operation.

TECHNIC OF OPERATION.

Apply an Esmarch bandage above the knee.

Having surgically prepared the foot, make a longitudinal incision one and one-half inches in length on the inner border of the foot, directly over the astragalo navicular articulation. Carry this incision boldly down to and opening into the joint.

Expose the head of the astragalus by retracting the joint ligaments. Force the head of the astragalus downward and inward and have it held in this position by an assistant.

With a small chisel remove the articular surface of the head of the bone. Care must be taken to maintain the contour of the head of the astragalus. The removal of this cartilaginous surface should be very thoroughly performed. No part of it should remain.

The articulating surface of the navicularis is then treated in the same way.

With a small bone curette both of these surfaces are then thoroughly but smoothly curetted. It is then seen that when the forefoot is inverted the surfaces are evenly in apposition.

The deeper structures are now closed with four or five interrupted sutures of chromicized catgut No. 1. The skin is united with continuous plain catgut suture No. 1.

The foot is put up in a plaster of Paris cast in marked inversion, care being taken by exaggerating the position of varus to bring the head of the astragalus in apposition to that portion of the articulating surface of the navicularis approximating the cuboid. By this means when, later, the foot is freed from its plaster dressing, the forefoot carries with it to a certain extent the astragalus in an outward direction in contradistinction to the inward rotation which it takes in a weak foot.

The operation should not be performed before eight years of age.

POST OPERATIVE TREATMENT.

The plaster of Paris dressing should not be removed for five weeks in older children, and six weeks in younger.

After the removal of the plaster dressing the foot will be found to be in an over-corrected inversion. This will gradually decrease until at the end of three months from the time of the operation, the patient will be walking with ease and comfort.

It is well to have the inner border of the heels built up a full three-sixteenths of an inch and continue to be so worn for a year after the operation.

THE TREATMENT OF JOINTS STIFFENED BY WAR INJURIES.

BY MITCHELL LANGWORTHY, CAPTAIN, M.C., U.S.A.,

First Orthopædic Unit, A. E. F., France.

It is the purpose of this article to discuss briefly the principles and practice of the treatment of limited function of joints due to changes in the soft tissues only, which are the result of war injuries.

The changes in these tissues, namely the capsule, ligaments, muscles and tendons, are those of the scar formation and loss of substance, or both. In those wounds which have healed by the slow, open drainage process, scar formation predominates. In those where an early suture has been possible, loss of substance, either the result of the injury itself or the operation necessary to make early suture possible, is the important factor.

It is essential before considering treatment to separate as definitely as possible this group of cases from those in which changes in the bone itself and its articular cartilage are limiting function. Also it is necessary to determine whether bony changes account for all or only a part of the limitation. The history and clinical course of the injury will furnish very important information. Combined palpation and manipulation will, in experienced hands, be the determining diagnostic measure. There is a characteristic "feel" to a joint whose movement is limited by soft tissue changes, even when practically no movement can be obtained which differentiates it from the obstruction to function caused by bone changes. If this can not be made out definitely, it is wise to repeat the examination with the patient anaesthetized, when the difference is more easily detected with the elements of pain and muscle contraction removed. Diagnosis is completed by radiographs of the joint, and treatment should almost never be started until these are seen to show no bony or articular obstruction to movement. These cases constitute a large portion of those which will come to reconstruction hospitals for several years, and proper treatment will make them one of the most satisfying groups of results.

The principle of treatment, which in the writer's opinion is most universally applicable, is that of gradual movement of the joint by a series of small movements which increase daily, starting always from the original position, and followed by immobilization for about 24 hours in the new position. To illustrate exactly what is meant, let us start with a knee stiff in full extension of 180 degrees. This should be bent to perhaps 178 degrees and immobilized in that position until the next day. Then the immobilization is released and the knee is

fully extended back to 180 degrees several times, both actively and passively, and then bent again, perhaps to 175 degrees, and immobilized in that position until the next day. Each day the angle is increased, always, however, being extended to 180 degrees several times before immobilization in the new degree of flexion.

Two other methods have been employed with success in certain cases; one, manipulation under anesthesia with or without immobilization following, and the other the continuous application of a stretching force with an elastic or spring tension. Without entering into a theoretical discussion of the relative merits of these methods, it seems wise to mention their outstanding faults as found in practice. Cases of stiff elbows and knees which have been manipulated under anesthesia have frequently come into the writer's wards with a violent lighting up of the old infectious process which has been lying dormant in the tissues. This is an ever present danger. Also, after manipulations of this kind, if the joints are immobilized for any length of time, in a large number of cases they are found to be just about as stiff in the new position as they were in the old; due probably to new adhesions formed as a result of inflammatory processes set up by the tearing of old scar tissue and even normal tissue where there has been shortening due to loss of substance. If these joints are not immobilized, the attempt to keep up movement has in many cases been a failure, for the patient himself will not help in this because of the pain associated with movement. In reality he keeps the joint as comfortable as possible by carefully preventing motion, which immobilization for probably more than 23 hours a day very much overbalances what good might come from a few minutes of exercise and massage given the joint by a busy attendant.

Good results are possible and no harm is done by the method of continuous stretching with elastic or spring tension. The writer believes, however, from a comparison of cases that a longer time is required to move the joint through the desired arc, and that a longer period of subsequent exercise and massage is necessary than with the method he is advocating. The reasons for this which suggest themselves are, first, that due to the constant tugging of the stretching device and the continuous discomfort, the muscles controlling the joint are constantly resisting movement, and, second, that sufficient time is not allowed for the actual lengthening of the tissues by new cell growth.

The method which will now be described avoids the faults of the other methods and has certain advantages. It can be employed so gently and can be so easily graduated that the great danger of light-

ing-up latent infection is minimized. For this reason also it can be employed much earlier, which is a distinct advantage. The ability to return or resume the original position will not be lost. In other words, a knee stiff in complete extension which is being flexed will not lose the power to completely extend while regaining flexion. The most valuable feature of this method is the relaxation of all tissues which takes place during the daily period of solid immobilization. This occurs to such an extent that the force necessary to increase the range of movement each day is minimized. The process really becomes one of repeatedly taking up slack. Also it would seem probable that the short tissues were allowed time to grow longer, to lengthen constructively, rather than to be destructively stretched. There is, too, a psychical value, which should not be underestimated. Observation by the patient of the daily improvement and the fact that the patient does with his own muscles move the limb from the starting point through a gradually increasing arc, undoubtedly shortens the duration of treatment. Thus also is accomplished a gradual reëducation of muscles which have not been functioning. This is not nearly so easily accomplished after a forcible manipulation under anesthesia, in which case the greatest desire of the patient is to prevent the pain which movement causes.

The following paragraphs consist of descriptions of several simple forms of apparatus which the writer has devised for the application of the method which he is advocating. The success which has followed the use of these simple devices has led the writer to believe that the principle is sound.

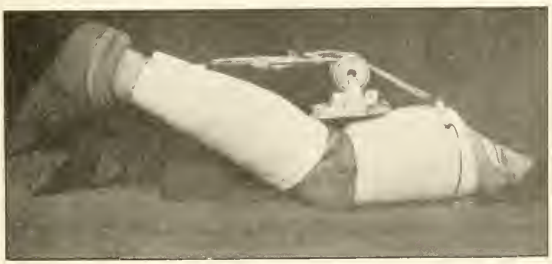


FIG. 1.—Apparatus for immobilization used in the treatment to regain flexion of a knee joint stiff in extension.

FIG. 2.—The same as Fig. 1, showing how the small board should be arranged to prevent downward slipping of the thigh cast and to prevent its lower edge from pressing into the popliteal space.

TREATMENT OF A KNEE STIFF IN EXTENSION.

See Figures 1 and 2.

Over three months were spent with almost a daily trial of different apparatus and modifications of them, before the following simple, mechanically correct, light and comfortable flexion method was worked out. The knee is allowed to be its own hinge. No simple hinge at the knee will do because it will not correspond to the hinge of the joint, and strain and discomfort will be coincident with its use. First, a snug plaster cast is applied to the leg from just above the malleoli up to the point on the leg which touches the thigh when the knee is flexed to 90 degrees. Another cast is applied to the thigh reaching up as high as possible and down to the point on the thigh which touches the calf when the knee is fully flexed. A piece of telephone wire is bent and incorporated in the plaster and caused to project at the back of the upper end of the leg cast so that the end of a board three inches wide laid against the back of the knee and pushed downward from above will be maintained about one inch below the edge of the upper end of the leg cast. A similar piece of wire is incorporated in the back of the thigh cast and caused to project half way between the upper and lower edges, so that the end of the board laid against this wire loop cannot progress upwards. At the extreme upper edge of the thigh cast and at the lower edge of the leg cast posteriorly a wire is incorporated in the plaster and allowed to project as a small loop. A piece of small rope and the light board mentioned above complete the materials necessary for beginning treatment.

The patient is placed face downward on a table, in the top of which it is well to have cut two slots so that a wide strap can be placed over the thigh cast, through the slots, and anchored below for the purpose of holding the thigh firmly on the table. The ankle is then grasped around the malleoli and raised and with the knee thus flexed, no matter how slightly, the board is marked so that it may be cut to fit between the two wire projections in the casts above and below the knee. At the time this measurement is made the thigh cast must be shoved as high as possible, since it has a tendency to slip down, due to the conical shape of the thigh. When the board is ready, the strip of webbing or rope is passed through the small loop at the lower end of the leg cast and the loop at the upper end of the thigh cast. The knee is then flexed as far as comfortable by lifting the foot. The board is slipped between its wire loops and the rope is pulled tight and tied by an assistant. The little board placed as directed prevents the thigh cast from slipping down and also, because its upper end is anchored so high up on the thigh cast, prevents the lower edge of the cast from pushing forward into the popliteal space. On the correct arrangement of this small piece of board and the wire loops which hold it hangs the entire efficiency and comfort of the apparatus. The next day the patient is again placed on the table, the rope is untied and the board removed. The knee is passively extended and as much active flexion and extension as is possible is performed by the patient several times. This done, the knee is flexed as much as possible in the same way as at the beginning of treatment, and the board is marked again to fit in between its wire loops which, with the increase of flexion, will be approximated. When the board has been shortened, flexion is repeated, the board slipped in and the rope tightened and tied as before. It is sometimes difficult to tie the rope so that some of the flexion is not lost. This may be remedied and the rope made as tight as desired by laying enough small blocks of wood on the board to reach and tighten the rope, as in Fig. 1. It will be seen that this is not in itself a device for flexing the knee. It is rather a means for immobilizing the knee in the position in which it is placed by the operator. It does the same work which a series of complete circular casts, including thigh, knee, and leg, would do, the old one being removed and a new one being applied each day.

Flexion of an elbow stiff in extension is accomplished in exactly the same way as that just described for the knee, the arm being prepared as was the thigh, and the forearm as was the leg.

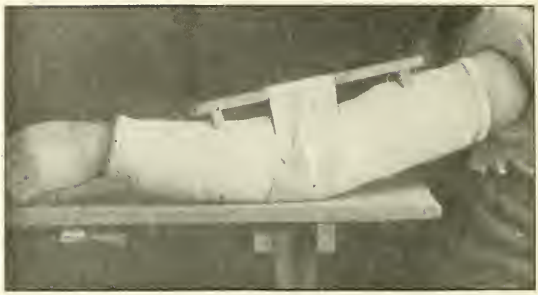


FIG. 3.—Apparatus for immobilization used in the treatment to regain extension of an elbow stiff in flexion.

FIG. 4.—The same as Fig. 3, but before the adhesive strap is applied, showing the gap in the cast and the position of the board.

FIG. 5.—The same as Fig. 3, but with the board and adhesive strap removed showing the gap in the cast after complete extension has been secured. The patient is able to completely extend the elbow and also to flex it back to the starting point.

TREATMENT OF AN ELBOW STIFF IN FLEXION.

See Figures 3, 4 and 5.

A continuous circular plaster cast is applied from as high up on the arm as possible to just above the wrist with the elbow extended as much as possible. The forearm had best be in the position of supination. With a sharp knife, just before the plaster has set completely, a transverse cut is made through the entire thickness of the cast, extending across the front of the line of the elbow joint from slightly behind the internal and external condyles of the humerus. It is well to let the plaster then harden until the next day, when extension is begun by holding the arm flat on a table and pressing down on the wrist. The linear cut becomes a gap. Immobilization is accomplished by placing a board about three inches wide and about twelve inches long on the cast lengthwise over the gap, and then encircling the cast and the board with a wide strip of adhesive tape which runs around the point of the cast over the elbow and over the middle of the board. The following day the adhesive strap and the board are removed. The elbow is passively and actively flexed and extended. It is then immobilized in an increased degree of extension by reapplying the board with the adhesive strap.

Extension of a knee joint stiff in flexion is brought about in exactly the same way as that just described for extending a flexed elbow.

FIG. 6.—Apparatus used in the treatment to regain dorsal flexion of a foot stiff in plantar flexion. With the foot dorsally flexed as shown, more extension of the knee than is shown was not possible. The cast is ready for the cut across the back of the knee.

FIG. 7.—The same as Fig. 6, showing the gap where the cut was made after complete extension of the knee. During the extension the foot has remained dorsally flexed.

TREATMENT OF AN ANKLE JOINT STIFF IN PLANTAR FLEXION.

See Figures 6 and 7.

Most of the cases in which the ankle is stiff with the foot in the equinus position are due to shortening of the Achilles tendon. In a large percentage of these cases, the foot can be considerably dorsally flexed if the knee is fully flexed, which of course approximates the origin of the gastrocnemius above the condyles of the femur to the insertion of the muscle into the os calcis. To stretch the gastrocnemius and Achilles tendon in these cases proceed as follows: Flex the knee completely. Dorsally flex the foot as far as possible. In this position apply a continuous plaster cast over foot, ankle, and leg. Do not include the knee. Let this cast harden. Now extend the knee as far as possible and continue the cast on the leg over the knee and high up on the thigh. Complete extension of the knee will not be possible because the gastrocnemius is pulled taut by a few degrees of extension. Before this part of the cast is completely set, make a linear cut through the back of the cast at the line of the knee joint, running forward on each side to within about one inch of the patella The next day extend the knee. The linear cut becomes a gap. The knee is then immobilized with a board and an adhesive strap, the procedure being throughout the same as that for the extension of the elbow. Lengthening of the gastrocnemius and Achilles tendon is much easier by this method than it is by the direct employment of the foot as a lever.

FIG. 8.—Apparatus used in the treatment to secure flexion of fingers which are stiff in extension.

FIG. 9.—The same as Fig. 8, seen from the opposite side.

TREATMENT OF FINGERS STIFF IN EXTENSION.

See Figures 8 and 9.

Flexion is gradually secured in these cases by the aid of a splint made as follows: One good plaster bandage five inches wide and five yards long and two pieces of thin webbing strap one inch wide are the necessary materials. The plaster bandage is lapped back and forth lengthwise on itself on a smooth surface to make a slab five inches wide and long enough to reach from the middle of the forearm to one inch beyond the finger tips. While making this slab, when one-third of the bandage has been used, the webbing straps are laid lengthwise one inch apart, running from one end of the slab to the other. The remainder of the bandage is then laid back and forth over these. This wet plaster

slab is then applied to the back of the forearm, wrist, hand, and fingers, and should extend one inch beyond the finger tips. The patient's wrist is then dorsiflexed and the plaster slab molded to fit the forearm, wrist, and back of the hand, rounding down smoothly over the sides. The part of the slab over the metacarpo-phalangeal and interphalangeal joints should not be molded down around the outsides of the index and little fingers, but should be left flat from side to side. If any flexion of the fingers is possible, the slab should be bent to take up this, but from side to side the slab should not be bent or arched. If this part of the slab is much too wide for the fingers it can be marked and later trimmed so that it is just a little wider than the hand at the metacarpo-phalangeal joints. Marks should now be made, with the splint still on the hand, just distal to the metacarpo-phalangeal and interphalangeal joints of the middle finger, and extending from one side of the splint to the other. These should be straight lines. The splint is removed when set, and with a sharp knife cuts are made on the three lines across the joints down to the webbing straps which are to act as hinges. The splint is then dried out thoroughly, preferably by baking in an oven. The entire border of the splint is covered with an adhesive strip one inch wide molded over the edges. The splint is applied by fastening it to the forearm and hand with one adhesive strap around the upper end of the splint and forearm and another strap across the part of the splint over the back of the hand and around the palm. These two straps are not removed during the daily adjustment. Gradual flexion of the fingers can now be started and each joint should be flexed separately. First the metacarpo-phalangeal joints are flexed as much as possible by the pressure on the section of plaster over the first phlanges. The flexion is retained by a strip of adhesive one-half inch wide passed across the distal edge of this section of the splint and then around that part of the splint covering the back of the hand to which it is fastened. The proximal interphalangeal joints are now flexed by pressure on the section of the splint over the second phalanges. The flexion secured is held by an adhesive strap across this section of the splint and around the back of the hand as before. Flexion of the distal phalanx is obtained by the same method and retained with a third adhesive strip across the distal section of the splint and around the part of the splint covering the back of the hand. Each day these three adhesive strips should be released, preferably by cutting them at the edges of the splint. The fingers should be brought back to complete extension several times and then flexed again as far as possible, joint by joint, and then fixed there till the next day.

If a digression from the particular class of cases which has been discussed may be permitted, it should be mentioned that the method of treatment here advocated is very useful in conjunction with the psychotherapy employed in cases of purely functional flexion and extension deformities.

Twenty months of continuous war orthopaedic work, first in a base hospital where patients with injuries received as far back as 1914 were treated, and then in a base hospital in the advance zone where the cases were treated a few days after the reception of the injury, has afforded the writer an opportunity to use and compare all the different methods, and he is convinced that treatment based on the principle herein described produces the best results in the largest number of cases.

A SURVEY OF THE ORTHOPÆDIC SERVICES IN THE U. S. ARMY HOSPITALS, GENERAL, BASE, AND DEBARKATION.

BY ROBERT B. OSGOOD, LIEUT.-COLONEL, M.C.

Soon after the beginning of the war, General Gorgas created the Division of Orthopædic Surgery in the Surgeon-General's Office, with Major (now Colonel) E. G. Brackett as its director, and Major (now Lieutenant-Colonel) David Silver as assistant director. Major (now Colonel) J. E. Goldthwait had sailed in March, 1917, as director of a unit of twenty orthopædic surgeons, whose services had been requested by the British Medical Department for work in the Orthopædic Centers of Great Britain, under Colonel (now Major General) Sir Robert Jones, director of Military Orthopædic Surgery for Great Britain.

Colonel Goldthwait returned to America in August, 1917, and went back to England in October with 42 more orthopædic surgeons for similar service. As more groups arrived later, well-trained orthopædic surgeons were released to France to help with the oganization of the Division of Orthopædic Surgery with the American Expeditionary Forces in France, of which he became director. Between 60 and 70 orthopædic men were constantly maintained in British hospitals during the war, and at the time of the signing of the armistice they numbered 91.

During the winter of 1917-18, the so-called Professional Divisions overseas were reorganized under a single director, Colonel William L. Keller, Regular Army Medical Corps, with Major (now General) J. T. Finney as Chief Consultant in Surgery, Major (finally General) William Thayer as Chief Consultant in Medicine, and Colonel Siler as Director of Laboratories. Colonel Goldthwait's title then became Senior Consultant in Orthopædic Surgery to the American Expeditionary Forces. This title he retained until he returned to America in March, 1919.

Overseas, the responsibility for all the bone and joint work outside the Evacuation Hospitals was placed upon the Senior Consultant in Orthopædic Surgery, acting under the Chief Consultant in Surgery, by circular No. 29, which read as follows:

AMERICAN EXPEDITIONARY FORCES.

Circular No 29. France, 21 May, 1918.

The following instructions are issued for the guidance of all Medical Officers, superseding Circular No. 11, C. S. O., March 6, 1918:

1. Injuries to the bones and joints, as well as of the muscles and tendons adjacent to these structures, represent a large percentage of the casualties of both the Training and Combat Periods of an Army.

2. To restore useful function to these injured structures is one of the purposes of the Medical Organization of the Army. The problems involved in this have to do not only with the cleaning and healing of the wounds, but also with the restoration of motion in the joint and strength to the part. This latter part naturally follows the first, but it is essential that the first part be carried out with reference to that which is to follow. Unless this second part of the treatment, the restoration of strength and motion, is carried out, much of the first part is purposeless.

3. To insure the man not only the proper treatment of this type of injury, but the proper supervision until he is as fully restored as possible, necessitates some form of radical control that makes it impossible for a man to be overlooked in inevitable transfers, from service to service, or hospital to hospital.

4. Since so much of the ultimate result in these conditions depends upon orthopædic measures after the first treatment of the wounds has been carried out, the following will govern:—

The Senior Consultant, Orthopædic Surgery, will, under the Chief Consultant, Surgical Services, make such recommendations relative to treatment of "injuries and diseases of the bones and joints, other than those of the head, as well as to the injuries or diseases (other than nerve lesions) of the structures involved in joint functions," as will insure early restoration of functions, shorten convalescence, and hasten return to active military duty.

He will also supervise the sub-divisions of surgery, pertaining to

bones and joints, in a manner which will permit the complete surgical harmony necessary for coöperation in treatment of these cases by either general or orthopædic surgeons, in formations from front to rear. To insure a minimum loss of function to the parts involved, uniform cooperation must be maintained by the Chief Consultant, Surgical Services, during both early treatment and all stages of convalescence.

5. To carry out the provisions of this circular, the Chief Consultant, Surgical Services, will make such provisions as are deemed necessary to insure a complete survey of these cases at regular intervals, and determine if the treatment is progressing in a satisfactory manner. Consultants in orthopædic surgery who are charged with the supervision of such cases within Hospital Centers and other formations will ordinarily be called in consultation for special cases, through the Commanding Officers of the units in question, and the Consultants will report to him prior to completion of their investigations. Commanding Officers of hospitals are expected to freely utilize the services of these consultants in the manner described above. Any recommendations made by them as to change of treatment, or transfer to some other professional service or hospital, will ordinarily, if the military situation permits, receive favorable consideration.

6. It is not the intention of this order to interfere with the routine work of hospitals, but to insure to the soldier proper supervision during the time of his treatment and the period of his convalescence.

M. W. IRELAND,
Brig. Gen. M.C., N.A.,
Chief Surgeon.

A reorganization of professional divisions in the Surgeon General's Office also took place during the summer of 1918. The three Divisions of Surgery, Medicine, and Laboratories, were created, and General Surgery, Head Surgery, Orthopædic Surgery, Roentgenology, and Urology, became sections of the Division of Surgery. Colonel Brackett became the Chief of the Section of Orthopædic Surgery. This is the organization which at present obtains, with Colonel Moncrief acting as Chief of the Division of Surgery in the Surgeon-General's Office.

The personnel for the Section of Orthopædic Surgery in the Surgeon-General's Office for the past six months has consisted of the Chief of the Section, Colonel E. G. Brackett; the Assistant Chief, Lieutenant-Colonel David Silver; Orthopædic Consultants to General and Base Hospitals and Camp Inspectors, Lieutenant-Colonel Frank Rugh, Lieutenant-Colonel R. B. Osgood, and Major Peters. Lieutenant-Colonel W. S. Baer and Major Z. B. Adams acted as Consultants for a short time after their return from overseas. There has also been an officer of the Sanitary Division in charge of the Orthopædic Medical Officer personnel, Captain Horace Morrison, numbering at its height, 850, on the

active list and embracing a total enrollment of over 1000. No service has been more important, and none performed with greater efficiency or in a more helpful spirit.

An officer has also been in charge of the orthopædic equipment and supplies; at first Captain J. L. Morse, and later, Captain Henry L. Mann.

Schools for intensive courses in orthopædic surgery have been held in Los Angeles, Omaha, Chicago, Washington, New York, Philadelphia, Oklahoma City, and Boston. Orthopædic surgeons have been assigned to the different National Army camps and base hospitals, to the evacuation and base hospitals organized for overseas service. Orthopædic services were established in the general and base hospitals designated to receive overseas cases. Orthopædic surgeons have been assigned to the ports of debarkation.

This résumé of the work of the different orthopædic services has been prepared by the Section of Orthopædic Surgery with the thought that it might interest many general surgeons and orthopædic surgeons who have either themselves been exempted to the Section of Orthopædic Surgery, or whose assistants or students have been serving as military surgeons under this Section.

The latest classification of conditions considered to be included under the heading of orthopædic surgery has been drawn up by a special committee appointed by the Surgeon-General in December, 1918. This classification is as follows:

1. All cases of amputations.
2. Deformities of extremities due to or associated with contractures of muscles, ligaments, and tendons.
3. Derangements and disabilities of joints; including articular fractures.
4. Deformities and disabilities of the feet.
5. Cases requiring tendon transplantation.

While this classification is not as inclusive as that adopted overseas, it furnishes on the whole perhaps as satisfactory a grouping of cases as could be made for the American hospitals. It overlaps frequently the classification considered as belonging to General Surgery. In a given case with two equally well qualified surgeons, one classed as a General Surgeon and the other as an Orthopædic Surgeon, the criterion as to which service the case belongs may be considered to be the relative importance of the coexisting conditions. For example, if the osteomyelitis connected with a contracture of the muscles and ten-

dons is the important feature in the soldier's recovery, the case would be considered as belonging to General Surgery. If, on the other hand, the joint fracture was the important element, the case would be considered orthopædic in spite of the fact that an unhealed osteomyelitis existed as well.

In general, it is to be said that the chiefs of the surgical services in hospitals have been extremely fair in the distribution of cases. It has been their policy to place the surgeon best qualified to care for the case or group of cases in charge of these patients without regard to the specialty to which he belonged. The main difficulty of the Chief of the Orthopedic Section has been to find for both overseas and America enough orthopedic surgeons who were well qualified to deal with the acute and chronic surgical problems as well as to supervise that detailed and often tedious special treatment which has to do with the return of the greatest amount of function in the shortest possible time.

Before an outline of some of the more important orthopædic services is attempted, it should be said that the cases returning to America presenting bone, joint, and muscle lesions as the result of battle wounds, have shown very conclusively the result of treatment received overseas. In the Army of Great Britain and France, in the early years of the war, the very high percentage of deformities which might have been prevented was truly alarming. The existence of this large percentage in the armies of our allies and the steps taken to prevent their occurrence were known to those in control of our medical department when we entered the war. It must always be a source of great satisfaction to the nation that the cases presenting these potentially crippling lesions which have returned to our home hospitals in America, have shown an almost negligible number of these preventable deformities. In fact, there has been a constant danger that, manned as our home hospitals have been until recently with medical officers without experience with our overseas forces, these deformities would develop in America in the course of the healing of wounds. As has been suggested above, the great value of this system of supervision overseas has been clearly demonstrated and the need of constant watchfulness at home has been emphasized. It has surely been our responsibility to see to it that the wounded soldier did not have an unnecessary burden laid upon him because we failed to appreciate the importance of instituting treatment looking to the attainment of the greatest amount of function as soon as the purely surgical aspects of the cases permitted. This treatment often must be associated with the operative measures undertaken to promote

the healing of the wound and the correction of deformities. It must be a concomitant treatment with the treatment of the wound, and not be postponed until the wound is healed.

Amputations. Early in the war, the French were faced by the problem of providing special numbers of artificial limbs for the mutilés. In the spring of 1915, Professor Tuffier made the statement that the amputations in the French Army at that time numbered 7,000, and that the annual output of artificial limbs in France from the regular commercial manufactory was 700. In Great Britain the same conditions have obtained and it has been impossible to supply well made artificial limbs as quickly as the conditions of the stumps allowed.

There are two very cogent reasons for fitting an artificial limb with a joint mechanism identical with the definitive limb which the soldier is eventually to obtain at the earliest possible moment which the condition of the stump, as far as healing is concerned, warrants. The first of these reasons is, of course, the purely economic one of wage-earning capacity, and affects the body politic. The second reason is that the soldier's initial effort and the early use of the stump muscles overcomes the atrophy of mental effort, and prevents the contraction of the muscles about the stump which leads to unfavorable positions. The plan has been adoped in the medical department of the American Army to supply gratis to the soldier an artificial limb which has all the essential mechanism of his final limb as soon as his stump allows. This limb is known as a "provisional limb" and under conditions of ordinary use, may be expected to last the soldier for a year. It is capable of a very considerable range of adjustment both as to length and, what is of more importance, as to size of socket. The legs which have been used have been made of fibre, are light, and have standard knee joint action. The arms have been made either of fibre or leather, reinforced with steel. The experiment has proved in the main, extremely successful. The men have been promptly fitted to these provisional limbs, have been taught to walk, and have been given special exercises for both arms and legs, and not discharged until a very considerable facility has been obtained.

Unquestionably, this arrangement has saved much time for the soldier and has decreased the time in which he was entirely dependent and possessed no wage-earning capacity. The burden of furnishing the final limb falls entirely upon the War Risk Bureau. This final limb cannot be fitted in case of leg amputation until six months or more have elapsed. The reason for this is that the so-called buckets or sockets

into which the stump fits in the definitive limb of the American type are almost universally made of wood, carefully routed out by hand to an absolute accuracy of fit. Once made, this cannot be materially changed, and if the stump shrinks still more, there must be another complete socket made as carefully as the first, which entails considerable expense and time. With this adjustable socket of the provisional limb, this shrinkage can be taken care of and the stump may be expected to be in a suitable condition for the fitting of a definitive limb several months before the provisional limb is worn out. This margin of time will undoubtedly be of service if, as seems likely, the supply of definitive limbs fails to be adequate to take care of the cases as soon as they are ready for them.

ORTHOPÆDIC AND AMPUTATION SERVICES IN GENERAL HOSPITALS.

Walter Reed General Hospital, Takoma Park, D. C.

This service began to assume important proportions in June, 1918, as the first overseas wounded began to return. Major T. M. Foley acted as the Chief of Service for several weeks and upon his assignment to foreign service was succeeded by Major Albert H. Freiberg as Chief, Major W. D. Erving as first assistant, Captain Carl C. Yount in charge of the amputation service, and Captain Carroll Storey as second lieutenant to the orthopedic surgeon. More and more wards were gradually assigned to the orthopedic service as the cases increased on rather a broad classification of bone and joint conditions.

In the early part of the service, there were many purely static conditions coming in from the surrounding camps and one of the most active parts of the work consisted in rehabilitating soldiers with weak and flattened feet. Lieut. Goldblatt's work in this connection should be especially mentioned.

Here, also, was worked out the outline for a standardized plan of organization of an orthopedic service of 250 beds or over. This standardized plan has been followed with practically no change in all the orthopedic services, in which, as sections of the Surgical Service in the General Hospitals, they have numbered over 250 patients. Along with this outline was sent an operative technique for orthopedic cases, meticulous, but less exacting perhaps than the British orthopedic technique, though an attempt was made to incorporate the essential features of the British scheme.

At the Walter Reed the amputation service soon assumed a very important place, which it has always retained. Over 800 cases of amputation have been in the wards of the Walter Reed Hospital at one time. Since it was the first amputation center to receive large numbers of cases, it has been here that the plan of provisional limbs, conceived by Lt. Colonel Silver, in charge of the amputation work, has been worked out.

Colonel Silver has acted as consultant to the Walter Reed Hospital in connection with the amputation work, and Major Kendall Emerson has been in active charge of the organization of this section, nominally carried on the rolls of the Surgeon General's office, but really spending almost all his time at the Walter Reed Hospital, operating upon the stumps which needed more surgery, devising methods of hastening healing, and with Major Yount, elaborating the details of the fitting of the provisional limbs and working out special appliances for the arm cases.

Major Yount, in charge of the appliance shop, has devised what seems to be the most practical terminal plate appliance for upper extremity amputations. To this end plate can be fastened very quickly, easily and securely, any form of hand-grasping device or recreation device, such as tennis-racket or ping-pong paddle.

After the armistice, Major Freiberg was relieved of duty at his own desire, and Major Erving assumed charge of the service, with Captain John O'Ferrall as assistant chief of the section. Captain Yount was in charge of the amputation section, with Major Emerson in constant attendance in a supervisory capacity.

The service in these days numbered over 1200 patients. Various reorganizations of the Walter Reed took place during the late winter and early spring, while Lt. Col. Edward Martin and Colonel Astley Ashhurst were acting as chief of the surgical service. This resulted in an entirely new distribution of cases. The amputation service still remained under Captain Yount, but nearly all the cases of osteomyelitis, and indeed many of the bone and joint cases requiring surgical attention, were divided into groups and placed under different medical officers, some belonging to the orthopedic section and some to the general surgical section. This new arrangement resulted in cutting down very materially the size of the orthopedic service *per se*.

At the Walter Reed, there has been most satisfactory coöperative endeavor between the orthopedic service and the reconstruction division, and very serious and more or less successful attempts have been made to perfect the curative side of the occupational shops. At the time of the present writing, the orthopedic staff at the Walter Reed Hospital numbers 19. Colonel Glennan has recently been made commanding officer of the Walter Reed, and Colonel Kellar, Regular Army, chief of the surgical service, Colonel Allison and Major Danforth have been assigned to the Walter Reed on the orthopedic service. Major Philip Wilson has been given full charge of the amputation section. On April 1st, there were 1154 overseas patients at the Walter Reed Hospital.

In April the following men were serving on the orthopedic section of this hospital:

Lt. Jas. H. Allen,
Lt. Loren F. Carter,
Lt. Jas. G. Denelsbeck,
Lt. Walter L. Denny,
Lt. Wm. O. Hill,
Lt. Louis J. Livingood,
Lt. Leland E. Phipps,
Lt. Hall Shannon,
Lt. Henry T. Simon,
Lt. Frank G. Walz,
Lt. Barron Johns,
Capt. J. R. Tilletson,
Capt. Carl C. Yount,
Major M. Mobley,
Major P. D. Wilson,
Major M. S. Danforth,
Colonel Nathaniel Allison.

Letterman General Hospital.

Crossing the continent now, we come to the Letterman General Hospital, which was one of the Regular Army Hospitals before the war, beautifully situated in the Presidio, San Francisco, overlooking the Golden Gate. In the early summer of 1918, Major R. L. Hull of Oklahoma City was assigned as orthopedic surgeon, and on the visit of the consultant in September, two wards were entirely given up to orthopedic cases, although no overseas cases had arrived.

Major Hull's personality made his service a most happy one. His mature judgment, his excellent operative ability, and his wide experience, added to a rather remarkable executive and administrative faculty made him an extremely valuable person in the hospital.

As soon as the overseas cases began to arrive, the service grew more rapidly, absorbing more and more wards. Major Hull became the supervisor of the physio-therapeutic work, embracing hydro-therapy and massage. At the Letterman there has been, for a considerable time, a rather elaborate hydro-therapeutic plant and this treatment has been one of the features of the hospital in charge of a sergeant, excellently trained by long experience in European spas.

Letterman also, has been designated as an amputation centre. Major Hull's very sad death from influenza and pneumonia in January, represents a loss not only to the service of the Letterman Hospital, where he had made himself respected and loved to a very unusual degree, but to the whole surgical profession. Fearless and kindly, firm yet extraordinarily gentle, he won everyone's heart, and made it possible for the specialty which he represented to perform an extremely useful service.

Major Hull was succeeded by Major Leo Eloesser, who had a wide experience in the German hospitals abroad, especially along orthopedic and prosthetic lines. He brought to the service this wide training and great energy. Under his leadership, both the amputation and the general orthopedic services have increased in importance. He has devised in the appliance shop a special form of artificial limb which bids fair to be almost as durable as the final definitive limb which the War Risk Bureau expect to furnish. This limb, known as the "Letterman Leg," is constructed on somewhat different principles than the common type of the American limb, getting its grip above the condyles of the femur and being really suspended from this point quite as much as from the shoulder strap of the ordinary type. The leg is being given a thorough trial.

Captain S. L. Haas had been first assistant to Major Hull, and is now to Major Eloesser. His very broad training as a surgical pathologist whose attention has been directed chiefly toward the problems of the growth of bone, and to joint work, has made him an unusually valuable man to the service. Captain Haas' service at Letterman has been interrupted by his coming to Washington to organize the Laboratory of Surgical Pathology at the Army Medical Museum. At the time of the present writing the orthopedic staff at the Letterman General Hospital numbers 17. On April 1st there were 772 overseas patients at the Letterman General. The following men were serving on the orthopedic section at this hospital:

Capt. John I. Boyer,	Lt. T. J. Nolan,
Lt. Chas. A. Craig,	Lt. Victor L. Roche,
Lt. Linwood Dozier,	Lt. Arnold M. Scholz,
Major Leo Eloesser,	Capt. John Thos. Whitty,
Capt. S. L. Haas,	Lt. Col. Chas. F. Eikenbary,
Capt. Herman V. Hoffman,	Lt. Col. W. I. Baldwin,
Lt. Alva F. Maine,	Lt. John Swancett.

U. S. A. General Hospital No. 1, Williamsbridge, N. Y.

The hospital at Williamsbridge has been under the officer of the port of Hoboken, and not directly under the Surgeon General's office, but has been functioning as a General Hospital, and still continues to so function.

The orthopedic service in this hospital has been in the hands of Captain Merritt L. Jones, formerly of Boston. Until the overseas cases began to arrive, the service was comparatively small, but noteworthy. Captain Jones has worked out numerous simple exercising machines, applicable to cases of foot-strain and extremely useful in the mobilization of partly ankylosed joints. Since the advent of the overseas cases, the service has increased in importance. While there has been no very sharp demarkation by wards between the orthopedic and

general surgical cases. Captain Jones' services have been utilized to a very large extent and almost all bone and joint cases and cases in which the restoration of function was the important factor, have been referred to him. Captain Jones has been the only member of the staff exempted to orthopedic surgery at U.S.A. General Hospital No. 1, Williamsbridge, N. Y. Several valuable critical reviews of groups of cases have been written by Captain Jones for publication.

On April 1st, there were 832 overseas cases at No. 1.

U. S. A. General Hospital No. 2, Fort McHenry, Md.

The orthopedic service at Fort McHenry in February, 1918, was assigned to Major S. C. Baldwin. He maintained his post until November, 1918, when he was assigned to the Port of Hoboken, and was made director of surgery of the port. He was succeeded by Major Guy C. Boughton. Overseas cases began to increase in number at Fort McHenry very rapidly, until on April 1st, 1919, there were more overseas cases at Fort McHenry than at any other U.S.A. hospital except Fort Sheridan.

After the sad death of Major Bissell, chief of the surgical service, Major A. R. Colvin of the orthopedic section was assigned to Ft. McHenry as the chief of the surgical service, Major Boughton still functioning as orthopedic surgeon. In February, Major Boughton was assigned to U.S.A. General Hospital No. 36, at Detroit, and Major A. R. Graves became orthopedic surgeon and has conducted the service with great distinction up to the present time.

A large Neuro-surgical service has developed here, and has many points of contact with the orthopedic section.

The orthopedic staff at U.S.A. General Hospital No. 2, at the present writing, is as follows:

Lt. Walter Thomas Anderson,
Capt. Edward W. Burt,
Capt. G. B. Capite,
Major Sydney M. Come,
Lt. R. L. Cook,
Lt. John Dane,
Major R. J. Graves,
Lt. T. M. Hart,
Lt. Raymond L. Johnson,
Lt. Geo. V. Lynch,
Lt. Anthony Mangiaracina,
Lt. John Revington,
Lt. H. L. Snaffer,
Capt. Louis I. Skirball,
Major R. T. Taylor,
Major A. H. Parsons,
Capt. Clark Kimball Peterson,
Capt. Eben W. Fiske,
Lt. Norman W. Gillespie,
Capt. I. J. Parsons,
Lt. John A. Key,
Major I. W. Livermore.

U.S.A. General Hospital No. 3, Colonia, N. J.

The general hospital at Colonia was started as a project soon after the beginning of the war, stimulated by the very generous offer of Mr. and Mrs. Charles Freeman to allow the Government to use their beautiful estate for building a hospital. The hospitals division of the surgeon general's office accepted this offer and construction began during the winter of 1917. Toward the end of the summer a plant of 1600 beds was ready, embracing curative shops and educational buildings, hydro-therapy and electro-therapy and massage rooms, as well as an unusually efficient operating and x-ray plant.

Major F. H. Albee became chief of the surgical service when the hospital finally began to receive patients in the fall of 1918, and has continued as chief of the surgical service ever since. This hospital being near the port of debarkation, it was from the beginning designated as an amputation and bone and joint centre. With the exception of the Walter Reed, more cases of amputation have been sent to Colonia than to any other hospital.

Occupational work has been developed at Colonia to a very extraordinary extent. Very exquisite articles have been made, embracing leather and wooden

articles of unusual design. They have greatly stimulated the patients' originality. A wave of interest in this work may be said to have swept the hospital and a very large percentage of the patients are engaged in some form of occupational work which is of a distinctly educational or decorative value.

The reconstruction work in general, under Major Johnson, has been most successfully organized.

There were on April 1st, 1452 overseas cases at Colonia. In April the following men were serving on the orthopedic staff of the hospital:

Major F. H. Albee,	Lt. George Y. Massenburg,
Capt. Thomas D. Buck,	Lt. H. F. Morrison (rec. dis.),
Lt. H. E. Bundy,	Lt. A. B. Pemsler,
Major Harold D. Corbusier,	Capt. Edw. J. Rose,
Lt. D. A. Curtis,	Lt. C. N. Silman,
Capt. J. Spencer Davis,	Lt. Elmer P. Weigel,
Lt. S. B. Easton,	Capt. L. B. Zintsmaster,
Lt. J. M. Gilchrist,	Major F. B. Van Wart
Lt. John G. Hart,	Major Henry C. Marble,
Lt. Ezra A. Jones,	Capt. Francis J. A. Bennett,
Lt. Armin Klein,	Capt. H. P. Mauck,
Lt. Thos. L. McNamara,	Lt. D. F. Elmendorf.

U. S. Army General Hospital No. 5, Ft. Ontario, N. Y.

U.S.A. General Hospital No. 5, Ft. Ontario, at Oswego, New York, is somewhat isolated from contact with other hospitals. Captain Philip D. Bunce has been quietly and most efficiently working as orthopedic surgeon at U.S.A. General Hospital No. 5.

The advent of more overseas cases has led to a very definite increase in the amount of his work, and an assistant orthopedic surgeon, Lieut. L'Episcopo, has been assigned. On April 1st there were 493 overseas cases at General Hospital No. 5.

U. S. Army General Hospital No. 6, Fort McPherson, Ga.

Fort McPherson was one of the earliest of the general hospitals to specialize in orthopedic work, and while at first this consisted largely of foot-strain, backstrain and other static conditions received from the neighboring camps, it gradually developed into a very active service under the direction of Lieut. J. R. Jones.

As overseas cases began to arrive, Capt. J. B. Woodman and Captain J. C. Wilson were assigned to Fort McPherson, and Lieut. Jones was sent overseas as orthopedic surgeon to an evacuation hospital.

Captain Woodman, on account of his surgical ability, served as assistant to Lieut.-Colonel Babcock, who had been made chief of the surgical service. In August, Captain Woodman was made commanding officer of a base hospital, and sent overseas,—Captain Wilson has remained as chief of the orthopedic section at this post up to the present time.

The service has been very active and a very large one, including bone, joint, and muscle cases. Captain Wilson has shown unusual surgical ability.

At Fort McPherson, there has been an amputation centre, at first supervised entirely by Captain Wilson, and later by Captain Oscar R. Miller, acting, of course, under the orthopedic surgeon. Captain Miller has recently been discharged and his place taken by Captain Thomas V. Magruder, who in turn has been succeeded by Captain Marcus Skinner. On April 1st there were 1372 overseas cases at Fort McPherson.

In April the following men were serving on the orthopedic section of this hospital:

Lt. Lee Brady (dis. rec.)
Lt. Clarence Henry Hyman,
Lt. Clarence A. Jacobson,
Capt. T. E. Wilkenson,
Lt. George B. Lynch,
Capt. Thomas V. Magruder,
Capt. Gilbert M. Mason (rec. dis.),
Capt. R. C. Robinson.
Lt. Raymond E. Watkins,
Capt. John C. Wilson.
Lt. C. M. West,
Capt. W. F. Collins.

U. S. Army General Hospital No. 9, Lakewood, N. J.

The development of the orthopedic service at Lakewood, N. J., is due almost entirely to the ability and energy of Capt. E. W. Cleary, who has been acting as orthopedic surgeon here since early summer of 1918. There was in the early days of the service the closest coöperation between Major Cleary and the chief of the surgical service, Major Halsey Thomas.

The distribution of cases was made in consultation and no sharp line was ever drawn, emphasis being placed upon the importance of the return of function. Those cases in which this conservation of function seemed to be the important element, were considered to be orthopedic in type.

At Lakewood, the coöperation between the reconstruction division and the orthopedic section has also been very close. Major Reagle was the first reconstruction officer here, and to his force and resourcefulness is due the fact that a very large percentage of the patients are engaged in some form of reconstruction activity.

Captain Cleary has devised several very ingenious and practical pieces of apparatus which he has carefully tried out before determining upon their final form. An abduction arm splint and an elbow splint for increasing motion in either extension or flexion are distinctly original in their type. The cases here have been of a somewhat lighter type than in many of the other orthopedic centers, since the hospital is listed to receive only a few bed cases on account of a supposedly considerable fire risk. On April 1st there were 643 overseas cases at General Hospital No. 9.

The following men were serving on the orthopedic section of this hospital in April:

Lt. Pio Planco,
Lt. O. W. Butler,
Capt. E. W. Cleary,
Lt. W. F. Cotting,
Lt. Howard B. Dulany,
Lt. Robert Goodman,
Lt. Dudley J. Morton,
Lt. Arthur F. Sergent,
Lt. Thomas B. Rafferty,
Lt. Joseph F. O'Brien,
Lt. Norman McL. Dingman,
Capt. J. H. Galbraith,
Lt. Col. A. H Cilley.

U. S. Army General Hospital No. 10, Boston, Mass.

In Boston, early in the war, the fraternal order of Elks became interested in building a hospital for reconstruction and other surgery, which would be turned over to the Government for the period of the war, and maintained after the war as a permanent hospital for this type of chronic surgery. A site was finally chosen on top of Parker Hill, next to the Robert Brigham Hospital. After the project developed, an arrangement was made with the trustees of the Robert Brigham hospital to include this in the plant for the duration of the war. The arrangement was a very happy one, since the equipment of the Robert Brigham, designed for chronic cases, was unusually good, both as to operating room facilities, x-ray plant, and physio-therapeutic department.

Major Frederic J. Cotton, originally exempted to orthopedic surgery, has been chief of the surgical service since the opening of the hospital. He was released to general surgery while acting as chief of the surgical service in the Walter Reed Hospital. His long interest and wide experience in bone and joint con-

ditions fit him especially for this post, since a very large proportion of the surgical cases sent to No. 10 are operative in type. In addition to the old plant of the Robert Brigham Hospital, and the new hospital plant proper, built by the fraternal order of Elks, the Government has taken over the buildings of the parental home in West Roxbury, which furnishes convalescent beds for 400 more cases.

U.S.A. General Hospital No. 10 is designated as a neuro-surgical centre and an amputation centre. There were on April 1st 674 overseas cases in Boston.

In April the following men were serving on the orthopedic section of this hospital:

Lt. Marshall L. Alling,
Capt. Louis A. Bolling,
Capt. John Brooks,
Capt. Wm. A. Clark,
Lt. Wm. H. Halley,
Lt. H. L. Keim,
Lt. Wm. G. McCormack,
Lt. Frank W. Marvin,
Lt. Nathaniel Mills.
Capt. C. E. Pamaci,
Lt. T. L. Story,
Lt. Arthur M. Washburn (rec. dis.),
Lt. James Blaine Montgomery.
Capt. A. A. Fenton.

U.S.A. General Hospital No. 11, Cape May, N. J.

U. S .A. General Hospital No. 11 at Cape May has been designated to receive cases of deafness, cases requiring oro-plastic surgery, and neuro-surgery. Major Chas. Frazier has been chief of the surgical service at Cape May, and chief consultant in America in neuro-surgery. There has been a small but very useful orthopedic service at Cape May under Major Roades Fayerweather.

Lt. Burkie has devised various simple light forms of hand and foot splints which deserve special mention. They can be made up in large numbers, are almost universal in their fit and are extremely efficient in their mechanical action. On April 1st there were 591 overseas cases at General Hospital No. 11.

U. S. A. General Hospital No. 12, Biltmore, N. C.

U.S.A. General Hospital No. 12 has had practically no orthopedic cases, although it was originally expected that it would be designated to receive them, and Major S. Fosdick Jones, who had returned from work overseas, was assigned to this hospital as orthopedic surgeon. His work has been extremely valuable, although not along orthopedic lines. A large number of empyema cases were congregated here and placed under his charge. He also has been acting chief of the surgical service part of the time, and has been one of the men upon whom the commanding officer has depended for administrative work in the hospital. At present there is no orthopedic service or orthopedic surgeon at Biltmore.

U.S.A. General Hospital No. 14, Fort Oglethorpe, Ga.

It was expected that Ft. Oglethorpe would serve as an important teaching hospital, and while the courses in the medical officers' training camp were going on, it did so serve. Various orthopedic surgeons have been connected with the medical officers' training camp at Fort Oglethorpe and with the General Hospital.

Major John Ridlon, Major Edwin Ryerson, Major Nathan, Lieut. Dudley Morton, have all taken part in the orthopedic activities. At present the hospital has a comparatively small number of overseas cases and it has not been found necessary to establish a distinct orthopedic section.

U.S.A. General Hospital No. 22, Philadelphia, Pa.

U.S.A. General Hospital No. 22 was one of the last general hospitals to be established as the demand for the reception of cases whose homes were in

this region became more insistent. Here, too, have been a comparatively small number of overseas cases, the orthopedic work at first being under the direction of Lieut. Colonel Rugh, assisted by Lt. Wm. C. Ely, and later under Major DeForest Willard, who brings to the service wide overseas experience gained in many positions of great responsibility and importance.

U.S.A. General Hospital No. 24, Parkview Sta., Pittsburgh, Pa.

U.S.A. General Hospital No. 24, was opened as a general hospital in the late winter with an orthopedic service which has grown to be of considerable importance. The chief of the orthopedic service has been Captain D. H. Moore, and with him has been Lt. Geo. E. Cramer. On April 1st there were 485 overseas cases at Parkview.

In April the following men were serving on the orthopedic section of this hospital:

Lt. Geo. E. Cramer,
Lt. Albion A. Cross,
Capt. B. H. Moore,
Lt. N. A. Wolff.
Lt. Simpson.

U.S.A. General Hospital No. 25, Ft. Benj. Harrison, Ind.

U.S.A. General Hospital No. 25 has been designated as a hospital to receive epileptics and mental defectives, but during the winter a certain number of overseas cases were sent here, including a good many important bone and joint lesions. It was thought best to establish a small orthopedic service at Ft. Benjamin Harrison and Major Neal S. McDonald and Captain P. P. Haslett were assigned. Very few additional bone and joint cases have been assigned to General Hospital No. 25 and Major Haslett has been transferred to General Hospital No. 32, Chicago, Ill.

U.S.A. General Hospital No. 26, Ft. Des Moines, Iowa.

U.S.A. General Hospital No. 26 has been one of the largest and most important orthopedic centres since its inception. Originally Major John Prentiss Lord was the orthopedic surgeon and upon his retirement from active service Major J. L. Porter of Chicago became chief of the section. The hospital has been designated to receive both amputation and neuro-surgical cases, and has always had a large number of overseas cases. The orthopedic service has been very large and efficient. There have always been most cordial relations between the orthopedic section and the general surgical section. Major M. B. Tinker, himself a most able bone and joint surgeon, has been chief of the surgical service and has taken keen interest in all the bone and joint problems, the conservation of function, and the prevention of deformities during the course of healing. The service is still running very large and the results have been extremely satisfactory. There were on April 1st 904 overseas cases at Ft. Des Moines. Capt. Baldwin, assigned to the amputation service, has designed an admirable adjustable paper socket.

Sixteen orthopedic surgeons have been associated with the service at Ft. Des Moines, as follows:

Lt. John E. Bentley,
Capt. R. D. Kennedy,
Lt. L. M. Maitland,
Lt. John Mitchell,
Capt. L. C. Nickell,
Lt. Col. Hiram W. Orr,
Capt. T. G. Orr,
Lt. H. L. Prince,
Major John L. Porter,
Lt. E. N. Roberts,
Capt. C. A. Warner,
Lt. J. E. Wattenberg,
Lt. J. R. Young,
Capt. Chas. Elroy Llewellyn,
Lt. James F. Hanna,
Capt. A. B. Phillips,
Major R. V. Smith.

U.S.A. General Hospital No. 28, Fort Sheridan, Ill.

The hospital at Fort Sheridan has been planned as the largest general hospital in the Army. 4800 beds have been provided. Most of the wards are of two story cantonment type, constructed with covered connecting corridors. The old post barracks have been converted also into most excellent wards and administrative offices, and the orthopædic section is housed in the main in these former post buildings. A cantonment structure ward in close geographic relation to the operating suite makes it possible to conduct an active operative service efficiently. Colonel Dean Lewis is chief of the surgical service and his long interest in reconstruction surgery and tendon work has given him a great appreciation of the importance of the chronic bone and joint surgery. Colonel Lewis is devoting most of his attention to neuro-surgery, a large and important group of these cases having been assigned to General Hospital No. 28. Major Edwin W. Ryerson has been acting as orthopedic surgeon at Fort Sheridan since it was opened, having been transferred to this hospital after the closing of the medical officers' training camp at Fort Oglethorpe, where he had been head of the orthopædic school. With him have been associated 15 orthopædic surgeons caring for the service, which has steadily increased in size and been unusually well organized. The work which Lt. John F. McNary has done in the study and recording of the peripheral nerve cases before they were turned over to the neuro-surgical services deserves special mention. On April 1st there were 1819 overseas cases at General Hospital No. 28.

In April the following men were serving on the orthopedic service of this hospital:

Lt. E. I. Barkheiser,	Lt. J. A. Saari,
Capt. T. B. Cracroft,	Capt. John D. Trawick,
Capt. H. C. Dozier,	Capt. Chas. Wilbur Mercer,
Capt. E. B. Fowler,	Capt. J. A. Holgren,
Capt. Emil Hoglund,	Lt. P. B. Greenberg,
Lt. Yngre Joranen—Medical,	Maj. Ralph Kaysen,
Capt. Albert B. McQuillan,	Capt. L. J. Quillin,
Lt. John F. McNary,	Lt. Arthur S. Sandler,
Capt. Rudolph S. Reich,	Capt. A. N. Wiseley,
Major E. W. Ryerson,	Capt. Herman Schuman.

U.S.A. General Hospital No. 29, Ft. Snelling, Minn.

U.S.A. General Hospital No. 29 was opened in the Fall of 1918, at Fort Snelling at the confluence of the Minnesota and Mississippi Rivers at the site of the famous old Ft. Snelling post. It is most attractively placed. The orthopedic surgeon since the opening of the hospital has been Major E. V. Rich. With great energy he has developed the service to a point of great usefulness. One of the remarkable features of his service has been the success which he has had in focusing the attention of the soldiers upon their recovery. A daily schedule of occupation and therapy was established in all the wards. Recreation itself even was planned, and talks on the history of the region were given. The policy of the government in relation to the future care of the men was outlined in lectures, and matters of general Army interest were discussed. There has been a great deal of bone and joint work and a service of very large size. An amputation service has been established at Fort Snelling and the fitting with provisional prostheses has been very speedily done owing to the close proximity of the Minneapolis Artificial Limb Company, who have a contract with the Government for the fitting of these provisional limbs. The occupational and reconstruction work at Ft. Snelling has been

developed very extensively and most cordial help in all occupational matters and in special furnishings for the hospitals have been given by the cities of St. Paul and Minneapolis, between which the Fort is situated. On April 1st there were 770 overseas cases at General Hospital No. 29. Major Rich has lately been discharged and Lt. Col. James C. Graves has been appointed orthopedic surgeon.

In April the following men were serving in the orthopedic section of this hospital:

Lt. Walter C. Aylen,
Lt. L. J. Brockman,
Capt. Chas. F. Clayton,
Lt. M. S. Davis,
Lt. Michael A. Desmond,
Lt. R. K. Finley,
Lt. Floyd D. Gillis,
Capt. E. A. Klein,
Capt. Jos. R. Kuth,
Capt. C. J. McCusker,
Lt. E. S. Porter,
Lt. Walter G. Sexton,
Lt. James Glowisley Walker,
Lt. Joseph Herbert Wolfe,
Lt. Col. J. C. Graves.

U.S.A. General Hospital No. 31, Carlisle.

It has been hoped that at Carlisle a specially efficient reconstruction hospital could be established, for the plant of the Carlisle Industrial School lends itself in an unusual way to this work. Shops of almost every description, which are well adapted for curative shops, are already established. Capt. R. V. A. Bliss has been orthopedic surgeon. The hospital has been open since the middle of the winter. On April 1st there were 655 overseas cases in this hospital.

In April the following men were serving in the orthopedic section of this hospital:

Capt. R. V. A. Bliss,
Capt. Scott A. Norris,
Lt. K. C. Peacock.

U.S.A. General Hospital No. 32, Chicago, Ill.

U.S.A. General Hospital No. 32 was opened late in January. It is situated at Drexel Avenue and 47th Street, adapted from the Cooper-Monotah Building, which was planned for a hotel. The property was taken over before the hotel had been entirely divided into small rooms and thus two large wards of 60 and 80 beds respectively were made possible. A few smaller wards of 10 or 12 beds were arranged, the rest of the hospital consisting of two or three bed wards. A small Zander room and a small gymnasium have been equipped. There are practically no reconstruction activities in connection with the hospital, but arrangements have been made whereby patients may receive instruction in one of the city manual training schools under very excellent instructors.

Lt. Colonel Vanamee has been orthopedic surgeon here, most ably assisted by Major Bacon, whose general surgical experience has been large and whose attention to the restoration of functions has been most constant. On April 1st there were 375 overseas cases at General Hospital No. 32.

In April the following men were serving in the orthopedic section of this hospital:

Major L. W. Bacon,
Lt. G. M. DeBeck,
Lt. H. S. Edson,
Capt. A. S. Lowenthal,
Lt. Michael F. McGuire,
Lt. Col. T. C. Vanamee,
Capt. P. P. Haslitt,
Capt. Carl Paulson.

U.S.A. General Hospital No. 35, West Baden, Ind.

U.S.A. General Hospital No. 35 is situated in the property of the former West Baden Hotel, advertised as the "Carlsbad of America." The former hotel is arranged in the form of a circle, 6 stories of double tier rooms surrounding a huge atrium surmounted by an enormous dome. While the original property did not lend itself well to hospital purposes, the adaptations which have been made have been very skillfully planned by the commanding officer, Colonel Bliss, and have resulted in an excellent working plant. All possible diversional opportunities have been given the men at West Baden in the bowling alleys, shooting galleries, swimming tanks, etc., of the old hotel property.

Captain Percy Roberts has been acting as orthopedic surgeon at West Baden and Major Halsey W. Thomas, formerly of U.S.A. General Hospital No. 9, Lakewood, N. J., has been chief of the surgical service. This hospital is to be discontinued on June 1st. On April 1st there were 213 overseas cases at West Baden.

In April the following men were serving on the orthopedic section of this hospital:

Capt. Jos. O'Dwyer, Capt. A. N. Wiseley (rec. dis.).

U.S.A. General Hospital No. 36, Detroit, Mich.

U.S.A. General Hospital No. 36, has been an interesting development. It has been established in the old and new buildings of the Ford Hospital. The plant of the old hospital furnishes an absolutely modern, completely equipped operating suite, laboratory, etc. The new hospital, connected by an underground tunnel with the old hospital, was originally planned to be of the hotel type with separate rooms and very small wards, to accommodate about 500 private patients. The Government, however, has adapted it so that many of the partitions were omitted and large wards arranged, with a corresponding increase in the number of beds totaling now about 1400. These, at the present time, are not all available, since construction has been somewhat delayed. The capacity is rapidly approaching the maximum under the energetic administration of the commanding officer, Colonel Cooper. Major Guy C. Boughton was the first orthopedic surgeon at General Hospital No. 36, and organized the service. He was replaced by Major F. C. Kidner late in February, who brought to the service very wide experience in the orthopedic centres in England. During the last part of Major Kidner's stay in England he was consulting orthopedic surgeon for all the American hospitals in England. In April there were over 500 overseas cases at General Hospital No. 36.

In April the following men were serving on the orthopedic section of this hospital:

Lt. I. I. Bittker,
Lt. Jacob H. Chalat,
Lt. L. B. Cowen,
Major F. C. Kidner,
Capt. Thos. S. Mebane,
Lt. Rudolph H. Ruedemann,
Capt. Carrol L. Storey,
Capt. S. E. Risendorff,
Maj. Geo. T. Hodgen,
Lt. Frank P. McCarty.

U.S.A. General Hospital No. 38, Eastview, New York.

General Hospital No. 38 at Eastview, New York, was opened in January, 1919, and late in March had over 600 overseas cases. They have in the main been of the less severe type. Major John Homans has been chief of the surgical service, and Major Clarence Coon the orthopedic surgeon, assisted by Lieut. Epstein.

U.S.A. General Hospital No. 41, Fox Hills, Staten Island, N. Y.

U.S.A. General Hospital No. 41, long functionated as a debarkation hospital. The chief of the surgical service has been Major Robert E. Soule. He has now assumed charge of the orthopedic work, since the hospital has become a general hospital, and a far greater scope will be given to his recognized ability as orthopedic surgeon. It is planned to make Fox Hills a very important general hospital. It has been designated as a center for neurological surgery. On April 1st there were 1315 overseas cases at U. S. General Hospital No. 41. The following orthopedic surgeons have been assigned to Fox Hills:

Major Robert E. Soule.
Lt. Chas. D. Reid, Jr.
Capt. Edward L. Cooley.

Embarkation and Debarkation Hospitals.

Orthopedic surgeons have been on duty at the embarkation hospitals in New York and Newport News inspecting the troops and serving also, since overseas wounded have been arriving, as supervisors of splinting on the transports before the cases were debarked.

When the cases first began to be transported there was a good deal of difficulty experienced because of the failure of the surgeons on the transports to realize the importance of maintaining fixation until the patients landed. The soldiers would often request to have the splints removed and their condition not being acute, the surgeons would frequently comply with these requests and in many instances unnecessary shortening and preventable deformities occurred. This difficulty was also experienced in the debarkation hospitals until surgeons who had had no overseas experience began to appreciate the fact that with these chronic bone injuries, accompanied by infection, union was very much slower than with simple fractures and that the calluses were much softer and more mouldable. Orthopedic surgeons were, on this account, sent to the ports of debarkation and a more careful supervision of splinting was instituted, both before the cases were removed from the transports and while under treatment in the debarkation hospitals. This has resulted in a very much more satisfactory condition as to splinting which obtains at present. The cases arrive at the general or base hospitals as a rule well splinted.

The principal embarkation hospitals have been at the ports of Hoboken and Newport News. Debarkation hospitals have also been established at these ports. Debarkation Hosptial No. 52, at Richmond, Va., has now been abandoned, but Debarkation Hospital No. 51, at Hampton, Va., in the buildings of the Old Soldiers' Home, still functionates. Debarkation Hospital No. 2, at Fox Hills, Staten Island, has now been changed to General Hospital No. 41. Debarkation Hospital No. 1, Ellis Island, N. Y.; Debarkation Hospital No. 3, at Greenhut Building, N. Y.; Debarkation Hospital No. 4, at the Polyclinic in New York; and Debarkation Hospital No. 5, at the Grand Central Palace in New York, are still being maintained at the writing of this article. To these hospitals have been assigned the following personnel:

D. H. No. 1, Ellis Island,
Lt. Edwin H. Spies.
D. H. No. 3, Greenhut Bldg, N. Y.
Capt. J. L. Bendell,
Lt. Frederick Gardner.
D. H. No. 4, Polyclinic, N. Y.,
Capt. Robt. M. Yergason.
D. H. No. 5, Grand Central Palace, N.Y.
Lt. Leonard P. Bland.
Lt. Geo. W. Cramm,
Lt. Chas. W. Bruninghaus.
B. H. Camp Merritt, N. J.,
Lt. Morris T. Koven.
B. H. Camp Mills, N. Y.,
Capt. E. R. Kelsey.

General assignments of the following orthopedic men have been made to the surgeon at the port of Hoboken for their assignment as he considers wise:

Major S. C. Baldwin, Director of Surgery of the Port.	Lt. F. B. Ring,
Lt. Col. G. W. Hawley,	Lt. Chas. Goldman,
Major R. D. Shrock,	Major Geo. J. McChesney,
Lt. George L. Chatlin,	Major Wm. B. Carroll,
Lt. Russell Pemberton,	Lt. W. W. Lasher,
Lt. Milo T. Easton,	Major C. D. Napier,
Lt. Chas. A. Wisch,	Capt. D. C. Paterson,
	Capt. L. N. Harris.

At Debarkation Hospital No. 4, Lt. Colonel George W. Hawley, assisted by Major Schrock and Captain Todd, has organized a special surgical clinic after the plans of Dr. Pietro Chutro, formerly of Paris. Dr. Chutro's bone work, especially on osteomyelitis, has been considered by many to be the most successful of any work overseas. He follows a special technique, and has his operating room specially organized. Dr. Chutro is to visit America and demonstrate his methods at Debarkation Hospital No. 4. Colonel Hawley is familiar with all these methods and is preparing for this visit. The clinic will be opened to all army surgeons.

Base Hospitals.

It will be impossible within the limits of this paper to do justice to the orthopedic activities in all the base hospitals. Only a few, therefore, will be mentioned which have been of considerable size and are contributing much to the welfare of the overseas patients.

Camp Devens, Mass.

At Camp Devens, the service was formerly under the care of Major Schirmer. He was transferred to Camp Meade in January, and Captain Fitzsimmons was made orthopedic surgeon. An excellent spirit of team play exists and an important service has been built up. On April 1st there were 576 overseas cases in Camp Devens.

In April the following men were serving on the orthopedic staff at Camp Devens:

Base Hospital.	Camp.
Capt. H. J. Fitzsimmons,	Lt. Charles L. Kerrick,
Lt. W. E. Clarke,	Lt. Harold Thomas,
Lt. R. S. Perkins.	Capt. Harold L. Burr,
	Capt. P. H. O'Conner.

Camp Dix, N. J.

The orthopedic work at Camp Dix was originally in charge of Captain Meisenbach who was discharged from the service soon after the overseas cases began to arrive. He was succeeded by Major Davidson, who, in turn was succeeded by Major McClain and Captain W. J. Merrill. The operative work has been quite extensive and a most interesting collection of bone and joint cases has been sent here.

The number of overseas cases in this hospital on April first was 1207. The following men were serving on the orthopedic staff at Camp Dix in April:

Base Hospital.

Major Alvah S. McClain,	Capt. J. A. Board,
Capt. Wm. J. Merrill,	Capt. Carl Ryden,
Capt. J. L. Moriarty,	Capt. Carson Coover,
Lt. E. N. Y. Kau,	Lieut. Thomas L. Smyth,

Camp.

Lt. Clarence F. Fowler,
Capt. John C. Herrick,
Lt. R. C. Hooker,
Lt. Herman M. Hurwitz,
Lt. S. B. Pearce (dis. rec.),
Lt. J. L. Linn,
Lt. C. A. Lee,
Lt. J. W. Smith.

Camp Meade, Md.

The orthopedic work at Camp Meade increased rather suddenly and required much operative attention. Lt. Colonel Ralph Fitch was assigned here on his return from overseas and met the emergency splendidly. After his discharge from the service, Major Schirmer became orthopedic surgeon. He, in turn, has been discharged. Recently a separate service has been organized by Major Billington, whose experience overseas especially well fits him for helpful service with bone and joint cases. The service is large and important. Lt. Colonel Lane, chief of the surgical service, takes keen interest in the functional treatment during the course of wound healing, and special curative work is being planned in the shops.

On April 1st there were 804 overseas cases at Base Hospital, Camp Meade, and the following orthopedic medical officers were serving:

Base Hospital.
Major J. W. Schirmer,
Lt. H. W. Wilam,
Lt. M. E. Harrell,
Capt. W. O. Markell,
Capt. A. G. Fuller,
Lt. Mickelthwaite,
Lt. H. K. Morrison,
Major R. W. Billington,
Lt. Charles H. Phillips.
Camp.
Capt. Dean S. Ince,
Capt. C. A. Cahn,
Lt. C. C. Nohe.

Camp Gordon, Ga.

During the mobilization period, an important orthopedic service was maintained at Base Hospital, Camp Gordon, under the charge of Captain Oscar Miller, who afterwards became camp inspector for this district. He was followed by Captain Jacobson and Captain Sanford, the latter assuming charge of the fracture cases. The base hospital at Camp Gordon has not been utilized for overseas cases until recently. On April 1st there were 506 overseas patients. Lieut. C. M. Turschel had been conducting the service admirably since Captain Sanford's transfer, and with the advent of the overseas cases, Major E. V. Kellar was assigned here also on April 1st.

The following orthopedic medical officers were serving on the orthopedic staff of this hospital in April:

Base Hospital.
Lt. Chas. M. Turschel,
Major E. V. Keller.
Camp.
Lt W. W. Beck.

Camp Custer, Mich.

The base hospital at Camp Custer has been almost a model base hospital under the extremely able administration of Colonel Irons. The orthopedic work here has been under the charge of Capt. Mercer, to whom all fracture cases as well as most of the bone and joint cases, have been referred. An excellent organization has been worked up in close cooperation with the general surgical service. The overseas cases have now been transferred to general hospitals, and the base hospital made a camp hospital. Before this change there had been over 500 overseas patients here. Captain Mercer has been assigned to Ft. Sheridan.

In April the following medical officers were serving on the orthopedic service at this hospital:

Base Hospital.
Lt. C. R. Crutchfield,

Camp.
Lt. R. H. Baker,
Lt. Carroll S. Thomas,
Lt. J. D. Blackburn.

Camp Grant, Ill.

The hospital is of almost the same size as the base hospital at Camp Custer. Overseas cases have also been received. No orthopedic service here, as distinct from the general surgical service, has been conducted, but Captain George Astley has had charge of the orthopedic work and has been extremely busy as consulting and operating surgeon. Recently he has been made chief of the surgical service, and several orthopedic surgeon assistants have been sent him. On April first there were 586 overseas patients at Camp Grant, and the following medical officers were on duty:

Base Hospital.
Capt. Geo. M. Astley,
Lt. Spencer P. Blim,
Lt. N. F. Crowe,
Lt. C. B. Young,
Lt. R. C. Wolfe,
Lt. J. B. Fitts,
Capt. Edward Jelks.

Camp.
Lt. E. N. Fischer,
Lt. E. O. Swanson,
Capt. H. W. Long.

Camp Sherman, Ohio.

The base hospital at Camp Sherman has had an active service during the mobilization period and has been designated to receive overseas cases as well. It has developed a very active section at first under the charge of Captain Powers, and later under the charge of Captain Chollett. Captain Chollett has had experience in both England and France and is extremely well qualified to care for a large bone and joint section. On April first there were 1076 overseas cases at Camp Sherman. The following men were serving on the orthopedic service of this hospital in April:

Base Hospital.
Lt. N. J. Koztraewzki,
Capt. H. C. Saltzstein,
Capt. John W. Powers,
Capt. Burt G. Chollett,
Lt. W. J. Fenton,
Capt. J. Roscoe Harry,
Lt. William Moncure,
Capt. U. P. Horger.

Camp.
Lt. H. J. Feaster,
Lt. C. L. McNeil,
Lt. J. C. O'Neill,

Camp Taylor, Ky.

The Base Hospital, Camp Taylor, has only recently developed a separate orthopedic service. Major E. A. Coleman, exempted to the section of orthopedic surgery, has been made chief of the surgical service, and Captain E. B. Mumford, who has had a year's foreign service in the orthopedic division, is acting as orthopedic surgeon. The number of overseas cases is large and the importance of bone and joint work is unquestioned. Major Codman's interest in bone and joint cases and his wide experience in bone and joint surgery are a great asset to the service. A very close liaison is being worked out between

the orthopedic convalescent cases in which joint function must be increased and the reconstruction activities. Careful records are taken of the weekly progress in joint motion. The work assigned is specially planned for the restoration of function.

On April first, there were 834 overseas cases at Camp Taylor. The following medical officers were serving on the orthopedic service at this hospital in April:

Base Hospital.
Capt. T. A. Bryan,
Lt. H. E. Powers,
Major E. A. Codman,
Capt. J. B. Young,
Capt. Louis H. Mayer,
Capt. E. B. Mumford,
Lt. F. N. Potts,
Capt. T. H. Stewart,
Capt. O. P. Hodge.

Camp.
Lt. Geo. E. Lyons,
Lt. James L. Shoemaker,
Lt. E. L. Heakel.

Fort Riley, Kansas.

At Base Hospital, Fort Riley, Major Napier was assigned early in the mobilization period and continued in this capacity until the latter part of August, 1918. He was then replaced by Major Mark Rogers, who developed a most useful service in connection with the large numbers of overseas cases which began to be sent home. Upon Major Mark Rogers' discharge from the service, he was replaced by Major Hobby, who had formerly been stationed at Camp Funston. Major Dickson, after a year's experience in Europe, has now been assigned to the base hospital at Fort Riley and brings to the service a great ability and splendid training.

On April 1st there were 476 overseas patients in this hospital, and the following orthopedic officers were serving:

Capt. Edw. Adams,
Capt. W. M. Holtz,
Major F. D. Dickson,
Capt. Marion Truehcart.

Camp Upton, N. Y.

The base hospital at Camp Upton has been receiving overseas cases for several months, and the orthopedic service has been ably conducted by Captain H. B. Thomas of Chicago. On April 1st there were 778 overseas cases at the base hospital, and the following medical officer personnel was serving on the orthopedic staff:

Base Hospital.
Capt. H. B. Thomas,
Lt. Alfred H. Yason,
Lt. Lysander S. Kemp,
Lt. Wm. H. MacKay,
Capt. C. M. Allaben,
Lt. E. A. Spies.

Camp.
Capt. J. C. Davis,
Lt. Chas. S. Bergman,
Lt. Horace H. McCoy,
Lt. Nathan Rosenberg,
Lt. Gerard J. B. Schoof,
Lt. Geo. L. Venable.

Camp Lee, Va.

At the base hospital at Camp Lee, near Petersburg, Va., the surgical service under Major Parker has been excellently organized and the orthopedic section has functionated efficiently under Capt. Wheeden, Major Jerrauld and several assistants. A good *esprit de corps* exists, and overseas wounded have done excellently well. On April 1st there were 419 overseas cases at the base hospital, and the following orthopedic surgeons were on duty:

Base Hospital.
Capt. A. A. Weeden,
Lt. Hugh I. Battey,
Capt. A. A. Fenton,
Lt. W. W. Tracey.

Camp.
Lt. E. B. Buchanan,
Lt. M. E. Simmons,
Lt. John D. Gillis

Camp Dodge, Iowa.

Camp Dodge has been an active mobilization and demobilization centre, near Des Moines, Iowa. At the base hospital, even before overseas cases were sent here, Major Test organized an orthopedic section which was kept very busy and served most usefully. With the advent of our overseas cases assistants were sent. Lieut. Wolcott, fresh from very extensive bone and joint experience overseas, both in England and France, was placed in charge of most of the bone and joint operative work, which he handled with much skill. Lt. Colonel Orr has now been made consultant at the base hospital, with Major Durham as orthopedic surgeon.

On April 1st there were 616 overseas cases at the base hospital and the following orthopedic medical officer personnel were assigned to Camp Dodge:

Base Hospital.
Major F. C. Test,
Lt. T. A. Willis,
Lt. T. S. Mark,
Lt. W. E. Wolcott,
Capt. E. D. Wise,
Major H. A. Durham.

Camp.
Capt. W. G. Bouse,
Lt. R. M. Baker,
Lt. L. K. Strate.

Camp Shelby, Miss.

At the base hospital at Camp Shelby, there has never been a large number of overseas cases, but the orthopedic service there has been well conducted by Lieut. L. F. Carlton. On April 1st there were 139 overseas cases.

Ft. Sam Houston, Texas.

The department base hospital at Ft. Sam Houston, Texas, has been nearly as important as a General Hospital during the early stages of the war. Major Ansel G. Cook has been stationed here almost since its opening, and his skill in handling the foot conditions has been greatly appreciated. Major A. R. Colvin was stationed here for several months before his transfer to Ft. McHenry, where he has been chief of the surgical service. For the last few weeks, Capt. J. T. O'Ferrall has been made orthopedic surgeon and has helped materially with the bone and joint operative cases. On April 1st there were 262 overseas cases. The following orthopedic surgeons were serving at this base hospital in April:

Capt. G. H. Applewhite,
Lt. R. J. Wharton,
Lt. Robert F. Patterson,
Capt. F. B. Hudson,
Capt. John T. O'Ferrall,
Capt. J. H. Shelton.

Camp Bowie, Texas.

Only a comparatively small number of overseas cases have been sent to the base hospital, Camp Bowie, but many of these have been important and an orthopedic section of the surgical service has been maintained. Recently Capt. Wm. C. Duringer has been orthopedic surgeon and in April Major Pinneo was assigned to the service. His overseas experience should make him capable of being of great assistance with the operative bone and joint work. In April there were 335 overseas cases in this hospital, and the following medical officers were serving on the orthopedic staff:

Base Hospital.
Capt. Wm. C. Duringer,
Major Frank W. Pinneo,
Capt. G. W. Day.

Camp.
Lt. Kent A. Bowman.

Camp Pike, Ark.

The base hospital at Camp Pike has had a small overseas surgical service, and an orthopedic section. Captain Charles H. Sanford became orthopedic surgeon, transferred here from Camp Gordon, and was afterwards made Chief of the surgical service, being replaced by Captain W. S. Roberts. Recently Fred H. Hodgson has been transferred to this port because of his wide overseas experience in the treatment of bone and joint conditions. On April 1st there were 250 overseas patients in this hospital, and the following medical officers were assigned to the orthopedic service:

Base Hospital.	Camp.
Lt. E. D. King,	Lt. J. W. Gordon,
Capt. Chas. H. Sanford,	Lt. Henry R. Leibinger,
Capt. W. S. Roberts,	Capt. Homer Sylvester.
Major Fred Hodgson.	

Camp Lewis, Washington.

The orthopedic service at Camp Lewis, both in the base hospital and in the camp, has always been active. Originally, Major E. A. Rich organized the work and after he was made camp inspector, the service at the base hospital was taken over by Captain Harding, whose successful conduct of it deserves special mention. No large numbers of overseas cases have been sent here, but the work has been extremely high grade. On April 1st there were 249 overseas cases in this hospital.

The following men were assigned to the orthopedic service at the base hospital at Camp Lewis in April:

Base Hospital.	Camp.
Major Maynard C. Harding,	Capt. John Carling,
Lt. Sherman Rodgers.	Lt. Geo. E. Lindow,
	Lt. Doxey R. Wilson.

This entirely inadequate and brief summary of the main activities of the Section of Orthopædic Surgery may suggest that an attempt has been made to meet some of the obligations of the specialty. Little has been said of the devoted and unspectacular work of the orthopædic medical officers assigned to camp work. Their original careful examinations of the draft cases and their later important services on discharge boards may seem to have passed unnoticed, but this is not so. It has been generally recognized as necessary and important by the Division Surgeons. If, in the treatment of the wounded soldiers, the attention of the surgeons has been directed to the importance of combining the conservation of function with the treatment of the wound itself, a service to surgery as well as to the soldiers may have been rendered.

Book Reviews

Prosthesis of the Lower Limbs. F. Martin. P. Masson et Cie., Paris, 1918.

Early in 1916 when the surgery of the Belgian Ambulance de l'Ocean at La Panne began to be divided up into specialties under the direction of Lieut.-Col. Depage, Dr. Martin was assigned the problem of prothesis. The present comprehensive monograph is the outcome of his work.

Part 1 deals with provisional prosthesis. In a general consideration of the subject the author states that before the war amputation cases were so few that surgeons were little concerned with them, but the large number of them occurring now renders the problem very important. Provisional prosthesis was not practised at all before the war, but has become necessary now to get the patients to moving about without crutches as soon as possible, to hasten their convalescence and improve their morale.

A provisional member must be worn on a stump which is sensitive or even painful, and must therefore be so adjusted as not to cause irritation, and must be capable of adjustment to follow the change in size and shape of the stump. A temporary leg should be applied to a leg stump in about eight days and to a thigh stump in about four weeks. No pressure or even contact should come on the end or lower part of the stump. The weight of the artificial limb either for a leg or thigh should not exceed five pounds.

Apparatus for Amputation of the Thigh. This consists of two parts: The plaster mold which fits the stump and the wooden pilon extending to the ground. The mold is made by placing the patient on a table lying on the side of his good leg and applying plaster bandages around the stump and well up over the pelvis. A reinforcement of wire trellis is placed under the ischium and an iron hook incorporated in the outer side at the level of the great trochanter. After several layers of bandages have been applied the two branches of the pilon (the two parts of a crutch serve well) are laid on, one along the inner and one along the outer side of the stump, and the remainder of the plaster applied over them, incorporating them firmly into the mold. When it has set, the mold is trimmed around the top at the level of the posterior superior iliac spine a little below Poupart's ligament and well above the gluteal fold. It is then removed.

After the plaster has dried for twelve hours the lower ends of the branches of the pilon are brought together and fastened to a solid block or cylinder of wood placed between them with a heavy rubber tip on the end. A spreader similar to that used in an ordinary crutch is fastened between the branches of the pilon up near the plaster portion. The finished apparatus is held on the stump by means of a webbing sling passing over the opposite shoulder and under the transverse spreader

of the pilon, and a second strap passing around the pelvis and under the iron hook at the outer side of the plaster. For cases in which the stump is less than ten centimeters in length, the iron hook which is incorporated in the plaster is made longer, its vertical part extending down and curving under the lower end of the plaster mold, thus making a firmer attachment for the pilon. Disarticulations at the hip joint require a higher trimming of the plaster, otherwise the apparatus is the same as that for the very high amputations.

Apparatus for Amputations of the Leg. Here special attention must be given to keep the knee mobilized. It is an accepted axiom that in amputations below the knee the patient must never walk with the knee flexed when it is possible to recover its mobility. The provisional leg is made by molding a plaster shape over the stump, incorporating in it two upright iron bands one on each side, which terminate below in a wooden block with rubber base, and above in a joint at the level of the knee to which is hinged two more uprights of iron riveted to a leather cuff encircling the thigh. Should the stump be less than fifteen centimeters long it will be necessary to extend the plaster part of the apparatus up to the level of the knee anteriorly to prevent its swinging forward on extension of the knee, and in some cases it will be necessary to hold it on by means of a webbing strap over the opposite shoulder.

All the above applies to provisional prosthesis. The second part of the monograph deals with definitive or permanent prosthesis.

The parchment-covered papier-maché or wooden artificial limbs with joints, which were little known in Europe before the war, are credited by the author to America. The ancient wooden legs were not fitted to the stump and little attention was paid to the support. The Beaufort leg was somewhat better since it was molded to the stump, but it was not planned on anatomical or physiological lines. The American type, while theoretically ideal, has many practical difficulties. The Belgian type includes the following principles: (1) Careful shaping of the stump to furnish good support; (2) reproduction of the anatomical form of the natural leg; (3) restoration of the normal statics; (4) provision for the same passive motion as that of the natural leg. Wood is used in construction of the apparatus in preference to metal or other materials because it has more advantages and fewer disadvantages than other substances. For interior finish a good layer of varnish is better than any kind of cloth or celluloid. The wood used in the making of the apparatus must be well seasoned. Some trouble was experienced from the use of unseasoned wood when the extensive manufacture of artificial limbs exhausted the supply of dry wood. The large thigh pieces cracked and warped. For this same reason it is necessary to have the dry wood of the apparatus covered with waterproof varnish or other dressing. Some of the American types of legs have a mechanism for the automatic propulsion of the leg on walking. This is something none of the other makes possess. The essential part of this is a spring (or elastic) which is put on tension when the leg is flexed and causes extension of the knee after the flexing force is re-

moved, provided the flexion is not more than forty-five degrees. If flexion is made to ninety degrees (as in sitting down) the same elastic, owing to the change in relative position of the points of attachment, maintains the flexion instead of returning the leg to extension. The long axes of the segments of the American leg are neither anatomical nor physiological. The upper and lower segments are aligned on an exact vertical axis and the axes of the knee and ankle joints are parallel with each other and with the floor. In the normal leg the axis of the femur and of the lower leg make an obtuse angle opening outward at the knee, and the plane of the ankle joint slants downward externally. Moreover, the long axis of the normal foot does not make a right angle with the axis of the ankle joint as it does in the American artificial leg. When a patient walks with such a leg his gait is asymmetrical because the artificial leg does not swing in the same angles as the real leg. This is conclusively demonstrated by cinematograph pictures obtained of walking patients. For this reason the gait is difficult and ungainly.

In the designing of the Belgian artificial leg it was the intention to overcome these defects. In the first place an accurate and practical method of determining the proper length of the leg was devised. The question of relative length as compared with the sound leg was settled as follows: Legs with immobile knees should be two to three centimeters shorter than the sound leg; those which have a knee joint capable of ninety degrees flexion should be the same length as the real leg. For making the measurements the patient is placed against a vertical frame with projecting markers to steady the shoulders, head, and hips, and a shelf for the stump to bear upon. Measurements are then taken to the floor from (1) the perineum, (2) the lower surface of the stump, (3) the internal condyle, and (4) internal malleolus of the real leg. With the patient in the same position a tracing is made on a sheet of paper fastened to the frame to record the outlines, both frontal and sagittal, of the sound leg. This tracing, reversed, serves as an accurate guide, together with the measurements, for the shape and angulation of the artificial leg. It is placed on the work table perpendicularly and the plaster mold of the stump hung in front of it so that the outline of the mold conforms to the tracing. A pilon with a solid wood block at the knee and another at the ankle serves as framework around which the lower leg is modeled in clay, conforming accurately to the tracing. The permanent leg is made over the entire model by gluing successive layers of thin strips of wood over it. These are laid longitudinally, spirally, and circularly alternately until fifteen to twenty layers are applied. When the water-proof glue is well dried the inner mold of clay and plaster is removed. There remains the making of the knee and ankle joint and the coupling of the segments. The knee axis should be posterior to the center, so that three-fifths of the diameter of the leg is anterior to it. The lateral plane is determined by drawing a line touching the lower end of each condyle as indicated on the tracing. The knee joint is provided with an automatic extension apparatus consisting of an elastic cord attached

to a shorter lever on the axle inside the leg. It is so set that on full flexion its force is exerted in the opposite direction, thus maintaining the flexion. The location and plane of the ankle joint is determined with the same care as the knee joint. A line drawn from it to the ischial support should pass in front of the knee joint. The joint is capable of lateral motion by virtue of the disposition of the axle which is in two parts set at an angle with each other. The foot is made of wood and conforms to the real foot in shape and in its points of support at heel, outer border and head of first metatarsal.

Pictures by cinematograph of a patient walking with the Belgian artificial leg show that the swing and joint motion is the same as that of the real leg.

For amputations below the knee a mold is made of plaster in the same manner as for a thigh stump, care being taken first to cover the prominent lead of the fibula and to pad the end of the stump so that no pressure will be made on those parts. The permanent leg is fashioned over the positive model by gluing successive layers of wooden strips over it as described above. It is made to conform to the outlines of the real leg and is provided with a wooden foot attached through an ankle joint as described above. Leather or canvas straps passing over the opposite shoulder serve to hold the leg on.

If the stump is less than eight centimeters long the apparatus should consist of a combined leg and thigh piece. It is so fitted that the main support comes on the ischium and the tibial stump bears no weight. For low amputations of the leg, however, provision is made for terminal weight bearing. The leg is fenestrated in front along the lower part of the tibial stump and is so shaped that part of the weight comes along the sides of the stump and part on the end.—*William Arthur Clark.*

Gun-Shot Fractures of the Extremities. Joseph A. Blake. Paris: Masson & Cie., 1918.

Dr. Blake's book is very concisely written, quite plain in its description of apparatus, and shows the radical change in our ideas regarding the treatment of both open and closed fractures which has taken place during the war. Some of the apparatus has been simplified since the book was written, but still the idea and the principle behind most of the treatment remains the same. Our more cumbersome form of immobilization and support has given way to more open work, frames, and increasing use of traction and support through weights.

It should be borne in mind that in septic cases, pus may burrow up to the body from a limb elevated too high, just as it can burrow down a dependent limb. This form of treatment with weights and pulleys needs constant supervision, as Dr. Blake points out.

On the whole, the illustrations and descriptions are well worth studying.

Orthopaedic Society Meeting

PRELIMINARY PROGRAM OF THE THIRTY-THIRD ANNUAL MEETING OF THE AMERICAN ORTHOPEDIC ASSOCIATION.

Atlantic City, Hotel Chalfonte, June 14, 16, and 17, 1919.

ANNOUNCEMENT.

It seems best to the Program Committee to limit the program to a few subjects of timely interest. From the list here given of those already offered, and from those still to be received, selection will be made for the final program, which will be ready about June 1st.

Sunday will be an important day. There will be a rally, at which Dr. J. E. Goldthwait will speak, and probably an adjourned business meeting, as there are many matters of importance to discuss.

E. G. Brackett, *Chairman*,
Surgeon-General's Office, Washington, D. C.,
David Silver,
E. W. Ryerson,
Program Committee.

LIST OF SUBJECTS.

President's Address.
H. P. H. Galloway, M.D., Winnipeg, Canada.

Surgery of Joints.

The Primary Suture of Joint Wounds. W. S. Baer, M.D., Baltimore, Md.
Arthroplasty of the Elbow. W. R. MacAusland, M.D., Boston, Mass.
Quiet Hip Disease. Henry Ling Taylor, M.D., New York City.

Surgery of Bones.

(a) Fractures.

Points to be Observed in the First Ten Days of the Treatment of Compound Fractures. H. Winnett Orr, M.D., Lincoln, Neb.
Treatment of Ununited Fractures Following War Injuries.
Frederick C. Kidner, M.D., Detroit, Mich.
The Restoration of Loss of Bone in Gun-shot Injuries.
Fred H. Albee, New York City.
Personal Experiences with Lane's Plates in Fractures.
Paul P. Swett, M.D., Hartford, Conn.
Treatment of Fracture of the Surgical Neck of the Humerus.
Frank E. Peckham, M.D., Providence, R. I.

(b) General Bone Affections.

Xanthoma of the Tarsus: Report of a Case and Review of the Literature.
Charles F. Painter, M.D., Boston, Mass.
Shortening of the Long Leg: With Report of a Case.
Aurelius R. Shands, M.D., Washington, D. C.
Non-union Following Corrective Osteotomies of the Tibia: Report of Two Cases.
Emil Geist, M.D., Minneapolis, Minn.
Transplantations of the Fibula. W. C. Campbell, M.D., Memphis, Tenn.

Surgery of Paralysis.

(*a*) *Peripheral Nerves.*

Diagnosis and Pre-operative Treatment of Peripheral Nerve Injuries.
Murray S. Danforth, M.D., Providence, R. I.
Treatment of Peripheral Nerve Injuries. Frederick C. Kidner, M.D., Detroit, Mich.
Results of Tendon Transplantation in the Treatment of Old Nerve Injuries.
Clarence L. Starr, M.D., Toronto, Canada.
Conditions Aiding in the Diagnosis and Prognosis.
Sydney B. Cone, M.D., Baltimore, Md.

(*b*) *General Surgical Problems.*

Operative Treatment of Paralytic Conditions of the Upper Extremities.
Arthur Steindler, M.D., Iowa City, Iowa.
Tenoplasty of the Hand. R. T. Taylor, M.D., Baltimore, Md.
Stabilization of the Ankle for Paralytic Deformities of the Feet.
Michael Hoke, M.D., Atlanta, Ga.
The Loop Operation for Paralytic Talipes Valgus, with Remarks on the Principles of Operative Treatment for Paralytic Deformities of the Foot.
Royal Whitman, M.D., New York City.
Certain Special Aspects of the Treatment of Infantile Paralysis.
Robert W. Lovett, M.D., Boston, Mass.

Reconstruction Problems.

(*a*) *Military.*

Type of Deformities Following Bone and Joint Injuries and the Treatment of Late Deformities. G. W. Hawley, M.D., New York City.
Early Occupational Therapy in the Treatment of Deformities and Other Conditions. A. H. Freiberg, M.D., Cincinnati, Ohio.
Practical Application of Occupational Therapy in the Hospital.
E. B. Mumford, M.D., Indianapolis, Ind.
H. C. Marble, M.D., Boston, Mass.

(*b*) *Industrial.*

Disability Periods as a Result of Injury to the Back.
James W. Sever, M.D., Boston, Mass.
The Industrial Rehabilitation of the Cripple.
Charles H. Jaeger, M.D., New York City.
Preventive and Prophylactic Orthopædic Practice.
Charles L. Lowman, M.D., Los Angeles, Calif.

Focal Infection.

Infectious Arthritides, with Especial Reference to the Foci of Infection.
Virgil P. Gibney, M.D., New York City.
Pathogenesis and Treatment of Affections Following Injuries or Infections of the Extremities. Philip W. Nathan, M.D., New York City.
Bone and Joint Lesions from Focal Infections.
Stewart L. McCurdy, M.D., Pittsburgh, Pa

Current Orthopaedic Literature

Numerals at head of each abstract are for use in connection with the official "Classification of Orthopædic Literature," published in the JOURNAL for January, 1917, reprints of which are obtainable from the JOURNAL office.

II. CARE OF CRIPPLES.

II, 2.

CRIPPLED CHILD—ITS PHYSICAL AND EDUCATIONAL NEEDS. A. E. Horwitz. *Missouri State Medical Association Journal.* January, 1919.

The author makes a plea for the establishment of a special municipal hospital for the treatment of orthopedic cases. There are 700 crippled children in St. Louis out of school at the present time. These children should be divided in the following groups:

1. Those with active disease who cannot properly be transported to school.
2. Those with active disease who can be transported.
3. Those who could travel unattended were proper provision made for their comfort while at school.
4. Strictly hospital cases.

For Class 1, the author advocates the establishment of a Hospital School where the physical and mental requirements can be cared for simultaneously.

For Classes 2 and 3, the establishment of a special school is advocated. Special seat should be provided children wearing apparatus to enable them to keep their minds with comfort on their studies.—*Edward Z. Holt, Atlantic City.*

III, 5.

AN ARTIFICIAL SYNOVIAL FLUID. Robert T. Morris. *Surg., Gynec., and Obstet.*, March, 1919.

Boroglycerine ounces 1, glycerine ounces 3, normal saline solution, ounces 4. After breaking up the adhesions in chronic inflammation of fibrous structures, the joint is injected full of the fluid. It acts in two ways, being retained in the joint from several days to a few weeks:

1. It is a hygroscopic fluid resembling normal synovial fluid; it furnishes a benign lubricant which offers a resistance to the reforming adhesions.
2. As an hygroscopic fluid it has a tendency to unload interstitial infiltrates from the fibrous tissue surrounding the joints when congested from chronic inflammation.—*Leo C. Donnelly, Detroit.*

III, 7, *b*, and XIX, 1.

INJURIES TO FINGERS. W. K. Hughes. *Medical Journal of Australia*, December 7, 1918.

This article describes the repair of an injury to a tendon of the finger. The author strongly urges the abolition of all scar tissue in order to prevent adhesions and to avoid sepsis. Scars from war wounds are unusually deep and include many pockets of septic material. The procedure in an isolated case is described. After the injured surface has been covered with good skin, an incision is made lateral to the tendon over the site of the injury. The tendon is carefully dissected above and below the injury for a considerable distance. It may be necessary to follow adhesions to the wrist or above it. The

tendon should be sutured with fine sutures. The finger should be gently moved the day following the operation.—*Edward Z. Holt, Atlantic City.*

III, 7.

Operative Treatment of Gunshot Wounds of the Spine with Grave Paralysis. Harold Neuhof. *Jour. A. M. A.*, Jan. 4, 1919, p. 37.

It is the belief of the writer that there is a proportion of the cases of gunshot wounds of the spine in which neither the cord nor the dura is injured, and that in these cases even with grave paralysis there is a probability of an oedema being the main element in the lesion. Four illustrative cases are reported.—*E. S. Hatch, New Orleans, La.*

IV. RESEARCH IN BONE GROWTH AND REGENERATION. SKELETAL ANATOMY AND PHYSIOLOGY.

IV, 1.

Spur-like Formation of Bone following Amputation. J. D. Morgan. *Arch. Radiol. and Electrotherap.*, 1918, xxiii, 154.

Article based on 250 personal cases of author at Granville Canadian Special Hospital at Ramsgate, and No. 15 Canadian General Hospital at Taplow. It describes the x-ray picture of healthy amputation stump showing bone rounded off clean, surrounded by a fairly uniform shadow of soft parts. Some bone atrophy may have occurred or a small amount of periosteal thickening may be present.

The majority of cases studied by the author showed irregularities in the end of the stump due to new bone formation, this varying from a small spicule to a relatively large wing, the majority of the spurs extending upward. They were frequently associated with pain and discomfort and also were the cause of persistent discharging sinuses. Re-amputation was necessary in many cases. The causes are probably operation by inexperienced operators, septic wounds, severe fatigue due to long transportation with infrequent dressings. As preventive measures the following are mentioned: The Bier treatment, the osteoplastic flap, the sub-periosteal and aperiosteal methods. A properly performed amputation, a clean wound and early weight bearing generally preclude the possibility of spur formation.—*Leo C. Donnelly, Detroit.*

V. TUBERCULOSIS.

V, 2, *a*.

Surgical Treatment of Pott's Disease. P. A. McIlhenny. *New Orleans Med. and Surg. Jour.*, Dec., 1918.

The author advises surgical treatment only in those cases of Pott's disease which cannot be cured by conservative treatment with a possibility of some motion, and the cases operated on should fall between early adolescence and middle age. When the disease has progressed far enough to cause marked deformity or paralysis, operations should then be resorted to. The Albee technique has been used by the writer.—*E. S. Hatch, New Orleans.*

VII. OSTEOMYELITIS.

VII, 2.

Acute Osteomyelitis in Children. A. C. Wood. *Pennsylvania Medical Journal*, December, 1918.

The subject is dealt with in minute detail, going carefully into the symptomatology and diagnosis of this conditon.

Early operation is advocated where possible.

There is nothing especially new brought out.—*A. G. Nichol, Nashville.*

X. CONGENITAL ABNORMALITIES (OTHER THAN DISLOCATIONS).

X, 3.

A Case of Congenital Radio-Ulnar Synostosis. Jonas C. Kopelowitz. *Jour. A. M. A.*, Jan. 4, 1919, p. 21.

One case is reported in which the x-ray showed intimate bony union of the upper six centimeters of the radius and ulna; both forearms were identical.—*E. S. Hatch, New Orleans, La.*

XII. CHRONIC INFECTIONS OF JOINTS AND BURSÆ (NON-TRAUMATIC).

XII, 7.

Mechanical Derangement of the Knee Joint. M. S. Henderson. *Journal-Lancet*, 1918, xxxviii, 523.

In this paper the principal conditions discussed are: (1) displaced semilunar cartilages, and (2) osteocartilaginous bodies of the knee joint. The anatomical basis for the frequency of the displacement of the internal cartilage is found in the intimate association between the inner body of this cartilage and the strong fibres of the internal lateral ligament and capsule to which it is attached. Any tension of the capsules tends to displace the cartilage. Some of the fibres of the quadriceps are inserted rather low down on the inner side of the capsule and this prolongation might pull in such a manner as to disturb the normal contour of the fibrocartilage. The anterior extremity is rather loosely inserted.

It is generally conceded that injury to the semilunar cartilage very rarely, if ever, occurs with the knee in full extension. When the knee is flexed to 150 degrees, the foot everted and rotated outward, the relaxed internal lateral ligament allows of some separation of the internal condyles from the internal tuberosity of the tibia. If the force continues with the foot in eversion, there is a tendency for the tibia to rotate outward on the femur, carrying with it the semilunar cartilage, and an attempt is made to extend the knee, the internal condyle of the femur rolls down on the anterior extremity of the cartilage and catches and holds it, and unless the cartilage slips from between the bones, it will be torn from its rather loose anterior moorings. If the rotation is considerable, the condyle of the femur may catch the cartilage rather far back and rip it longitudinally through its middle.

In certain cases the capsule may be so lax that the cartilage will slip out before severe damage is done. Pain, effusion, and disability will ensue. At operation the cartilage appears normal but too loose. Removal of the anterior three-fifths suffices.

With the first locking, a plaster of Paris cast should be applied, leaving it on six weeks. There will be few recurrences. In old cases, the loose ends of the cartilages may be palpated, there may be deposits of lime salts but, as a rule, the x-ray is only of advantage in ruling out osteocartilaginous bodies. The external semilunar cartilage should only be removed on a definite history of pain at the outer side of the joint in conjunction with distinct locking.

Next to internal semilunar cartilage, loose bodies have been the most frequent cause of derangement inside the knee joint. Foreign bodies are rare, but osteocartilaginous bodies are often found. They may be produced by (1) direct trauma knocking off a piece of the articular surface of the internal or external condyle of the femur or the patella, (2) osteochondrosis dessicans, (3) osteochondromatosis, (4) hypertrophic arthritis.

In osteochondritis dessicans, the end artery supplying the area probably becomes plugged, and the part becomes undernourished and sloughs off. The joint is unhealthy and a slight trauma tears off small fragments. Only two or three loose bodies are produced, and careful x-ray study usually shows a flattened area on the internal condyle.

In osteochondromatosis there is an associated synovitis, the lining is inflamed, somewhat thickened and pedunculated into teats. Some are fibrous and others are cartilaginous, becoming bulbous. They drop off, wander about the joint sac, and are nourished by the joint fluid. There are factors which suggest these to be of the order of new growths.

In older people, marginal osteophytic growths may break off in cases of hypertrophic arthritis and wander about the joint. A hypertrophic arthritis may follow loose joints in young people. A loose body or bodies produce catching or locking, with pain and effusion, followed by a period of rest, providing the body finds a resting place and is not caught between the articular surfaces.

Loose bodies in the joint demand removal after location by the x-ray. If only in the suprapatellar pouch, they may be removed under local anesthesia. A sharp cutting needle is thrust through the skin into the loose body, thus fixing it until one cuts down upon it. When the body is in the middle of the joint, usually near the internal condyles, the same incision is used as in removing the internal semilunar cartilage. If the entire compartment must be explored, the patella and lower fibers of the patella may be split longitudinally. Bodies in the posterior section may be worked through to the anterior section. If necessary, open the posterior compartment as a secondary operation. This is difficult in fleshy persons. Palpation within and without and the use of long forceps may be necessary.—*Leo C. Donnelly, Detroit.*

XVI. METABOLIC DISEASES AND DISEASES OF INTERNAL SECRETIONS.

XVI, 2.

Observation on the Cause of Rickets. Noel Paton, Leonard Findlay, and Alexander Watson: *The British Medical Journal*, December 7, 1918.

The authors, in the course of an investigation as to the cause of rickets, experimented on young dogs, and in this article come to the following conclusions:

Pups kept in the country and freely exercised in the open air, although they had actually a smaller amount of milk fat than those kept in the laboratory, remained free of rickets, while the animals kept in the laboratory all became rickety.

The observations seem to show that some other factor than diet is the prime cause of rickets in dogs and afford no evidence that milk fat (butter) contains any accessory factor protecting against the development of rickets. —*M. S. Henderson, M.D., Rochester, Minn.*

XVIII. STATIC AND POSTURAL DEFECTS.

XVIII, 1.

Good Posture. James F. Rogers, M.D. *New York Medical Journal*, January 4, 1919.

The author thinks that it is most unfortunate that the chief underlying cause of bad posture, that is fatigue, has not only been overlooked but actually scouted, and that, doubly unfortunately, by those who have preached the gospel of erectness.

In other words, instead of thinking that fatigue is produced by bad

posture, he is inclined to believe that the bad posture is produced by the fatigue, and that many of the children in school who assume bad posture are really undernourished and underdeveloped and the school seats and benches tend to further increase the bad posture.—*M. S. Henderson, M.D., Rochester, Minn.*

XVIII, 6.

FLAT FEET AND WEAK FEET. H. Scheimberg, M.D. *New York Medical Journal*, January 25, 1919.

The author is of the opinion that care should be taken in prescribing shoes and it should be done just as one would prescribe any medicine. He thinks that metal arch supports, particularly the commercial kind, are not good, and thinks that felt is a much better substitute. He favors muscle exercises as being a preventative of the development of flat feet.—*M. S. Henderson, M.D., Rochester, Minn.*

XIX. TRAUMATIC CONDITIONS.

XIX, 2, *a*.

A DEMONSTRATION OF THE ABDUCTION METHOD OF TREATING FRACTURE OF THE NECK OF THE FEMUR. Royal Whitman, M.D. *Pennsylvania Medical Journal*, December, 1918.

This subject is handled after the author's usual concise and lucid manner, bringing out the shortcomings of the ordinarily accepted line of treatment by traction. He points out the mechanical impossibility of accurately opposing the fragments of the fracture by this method.

The author shows that the abduction method, as devised by him, has a sound mechanical basis, and the practical application is as follows:

"The patient having been anesthetized, is placed on a pelvic rest provided with a perineal bar for fixation, the shoulders resting on a box of equal height, and the extended limbs being supported by assistants, who, by direct manual traction at the ankles, draw the patient firmly against the perineal bar. The assistant on the injured side continues the traction, at the same time rotating the limb slightly inward, while the surgeon lifts the thigh and guides the trochanter to its normal position.

When the displacement is completely reduced, as demonstrated by measurement, the two assistants simultaneously abduct the limbs, the one on the sound side slightly in advance of the other; in order to fix the pelvis and to demonstrate the normal individual range to which the injured limb must conform.

The typical attitude at the completion of the operation is full symmetrical abduction of the two extended limbs on a level pelvis with the landmarks on the two sides in exact correspondence. This assures adjustment and fixation; for, as has been stated, abduction places the fragments in the same plane, while the tension on the capsule which surrounds each must direct them toward one another, and finally exert mutual pressure. Meanwhile, the apposition of the trochanter and the base of the neck with the acetabular rim furnishes a second point of resistance to displacement, and the security of direct bony contact is further assured by the impotence of the muscles in full abduction. This is what is called anatomical or natural splinting, which is made effective by the attitude of the limb, an atittude that is maintained by a long plaster spica, extending from the axilla to the toes, applied in full abduction, full extension, and slight internal rotation."

The original dressing is retained for from eight to twelve weeks; after its removal the patient should be confined to bed until some voluntary control of the muscles is established.

During this period passive motion is used and weight bearing should not be allowed under six months.

The subject is well illustrated with roentgenograms, showing the various points of interest with reference to this condition.

The article is well worth consideration to those who are interested in this subject.—*A. G. Nichol, Nashville.*

XIX, 2, *a*.

Fracture of Cervical Vertebrae with Restoration of Bony Substance. L. F. Luckie. *Journal of American Medical Association*, February 1, 1919.

Major Luckie reports the case of an aviator who was injured in a fall from an aeroplane. The patient lay in the post hospital for the treatment of injuries in other parts of the body and it was nearly six weeks before the broken neck was discovered, which does not seem to speak well for the army medical service at Gerstner Field.

Without further care he was allowed to go home on a thirty days' leave and spent most of that time going from one doctor to another in Richmond, Va., and Baltimore, Md. He then returned to the post hospital and came under Major Luckie's care. His head and neck were bent to the right and forward, and he suffered great pain. Roentgenograms showed fracture of the fourth, fifth, and sixth cervical vertebrae, the fourth being dislocated on the fifth.

Major Luckie constructed a modified jury-mast whose halter was supported by a perpendicular standard resting on each shoulder. The standards were adjustable, and by this means the head and neck were made to assume an erect position in the median line.

In due time the pain and much of the rigidity disappeared. The patient went back into the service and passed all the aviation tests in Class A.

The article is illustrated by some excellent photographs and about five nearly useless skiagrams.—*Harold A. Pingree, Portland, Maine.*

XIX, 2, *b*.

The Triangle Splint in the Treatment of Compound Fractures of the Humerus. Major Philip Turner, R.A.M.C. *The British Medical Journal*, December 28, 1918.

Turner advises the use of the triangle splint for the treatment of fractures of the humerus, with a modification provided for the elbow to be held in flexion by use of padded ring on the opposite shoulder and a band around the perineum on the affected side, and holds the splint firmly to the chest wall.—*M. S. Henderson, Rochester, Mass.*

XIX, 2, *b*.

"No Splint" Treatment of Fractures about Shoulder in Humerus and about Elbow. J. W. Dowden. *Edinburgh Medical Journal*, December, 1918.

The author claims to be able to treat a simple fracture of the humerus in such a manner that the patient returns to work in from six to eight weeks as joiner, a dentist, or a mill worker. In ten years' experience with this method the author claims to "have never been disappointed nor has there ever been a case of non-union or bad result." The action of the muscles as a distorting agent is ignored. The arm is placed to the side of the chest. A Sayre dressing is applied.—*Edward Z. Holt, Atlantic City.*

Vol. I, No. 7 JULY, 1919 Old Series: Vol. xvii, No. 7

The Journal *of* Orthopædic Surgery

President's Address

READJUSTMENT TO CHANGING CONDITIONS.*

BY HERBERT P. H. GALLOWAY, M.D., C.M., F.A.C.S., WINNIPEG, CANADA.

Members of the American Orthopedic Association:

HAVING believed for many years that none of the honors open to a member of our profession are so worthy of being coveted as those which are within the gift of his own colleagues, I am deeply appreciative of your courtesy through which it becomes my privilege to occupy the President's chair at this thirty-third annual meeting of the American Orthopedic Association. Not only am I proud of the personal honor of having been elected to this office, but I am grateful for this evidence of your neighborly and fraternal sentiments toward the profession of the Canadian nation to which I belong.

This Association is meeting today under circumstances which cannot fail to arouse in us feelings of pleasure and gratitude, but which must at the same time deepen our sense of responsibility. The most frightful war in all history has happily terminated long before the most optimistic among us thought possible one short year ago; and with the lifting of that cloud of dread and uncertainty which rested upon civilized humanity for four dreadful years we once more realize how true it is that "there is a Divinity which shapes our ends, rough hew them how we will." Every page of the history of the universe reminds us

* Read at the Thirty-third Annual Meeting of the American Orthopedic Association, at Atlantic City, N. J., June 14 to 17, 1919.

of the fact that pain and sacrifice are the price of progress; and already there is abundant evidence that the terrible tragedies of this war, which so long drove humanity to the verge of despair, were merely the birth-pangs of a larger and better social and economic order, of a more rational conception of international life and right human relations.

Among the compensations which have grown out of the war the advance of surgical science is by no means least. While all departments of surgery have benefited, the war has done more to bring Orthopedic Surgery into its true inheritance than would have been accomplished by other agencies in many years; if indeed anything else would ever have brought about such complete emancipation of our specialty. Until somewhat recently the general surgeon was inclined to regard disparagingly, if not contemptuously, the orthopedic specialist, or, if more generous, to tolerate him in a good-natured and magnanimous kind of way. Now, however, it begins to look as though the general surgeon of the future may be compelled to explain how he became possessed of capacity and versatility so extraordinary as to enable him to be an all-round expert in a field which the great majority of surgeons find much too vast for thorough individual occupation.

But, while those of us who for years have fought for a reasonable degree of recognition now view proudly the pinnacle of deserved professional respect to which our specialty has been raised, it becomes us to recognize certain dangers and difficulties which lie ahead, the outlines of which are already so clearly drawn that it does not require the vision of a seer to recognize them. That process of readjustment of various human relations which is going on in many other spheres, and which we recognize as both desirable and necessary, must inevitably leave its impress to a greater or less degree on the future character and scope of that portion of the surgical field which we call ours. Our specialty is, to a certain extent, in a period of transition, and the difficulties and confusion which are more or less inseparable from all processes of readjustment to changing conditions cannot be wholly escaped, but we must never lose sight of the fact that the future complexion of orthopedic surgery will be determined largely by the completeness with which we of the present day recognize and shoulder the responsibilities which confront us.

What caused orthopedic surgery to separate from general surgery in the first instance? Was it not that the average general surgeon was lacking in his grasp of mechanical principles as applied to surgery, and that his patience and perseverance were unequal to the task of

solving by slow and laborious means the problems inseparable from the successful treatment of a considerable class of uninviting and neglected surgical cases? By combining surgical knowledge with the mechanical resourcefulness of the instrument maker, by becoming an expert in manipulative surgery and a wizard in the use of splints and plaster of Paris, the pioneer orthopedic surgeon managed with a minimum of operative skill to rescue from the ranks of the incurable multitudes the cases which at one time were regarded as practically hopeless. It was thus that orthopedic surgery established the first base from which its further invasion of the surgical field began. By the gradual addition to the ranks of the orthopedic specialists of surgeons having wider surgical training and experience than the pioneers, the boundaries of the specialty slowly widened, and, as was inevitable, conservatism was departed from, the younger orthopedic surgeons became increasingly aggressive and operative surgery came more and more, not merely to supplement, but often to supplant those slower mechanical processes which were characteristic of the earlier orthopedic régime. This natural evolutionary process has proceeded so far that the really representative orthopedic specialist of today is a surgeon whose training and experience enable him at will to attack any orthopedic problem with either the mechanical skill of a Taylor, a Thomas or a Sayre, or the finished operative technique of a Robert Jones. That is where the front line stands today, and where it must remain if orthopedic surgery is to continue to survive and prosper as a specialty.

But the war has had many unexpected results, among which was the discovery that certain classes of cases formerly regarded as belonging to the realm of general surgery were found to ally themselves so naturally with our specialty that many varieties of traumatism, which at one time no one regarded as orthopedic, are now generally accepted as belonging to our domain. The sudden enormous increase of orthopedic work created by the war, together with the expansion of the former boundaries of this specialty, created a demand for trained orthopedic surgeons which could not be met from the ranks of recognized specialists; consequently many young general surgeons have, during the war, enjoyed exceptional opportunities for acquiring a familiarity with military orthopedic surgery, and it is almost inevitable that not a few of these, enthralled by the intensely interesting work of physical reconstruction, will desire to be regarded as orthopedic specialists on their return to civil practice. In the situation which has arisen two dangers may be plainly discerned: The first is that some of those who are

recognized as orthopedic specialists, but who lack a really comprehensive general surgical training, may in future be tempted to accept cases which their general surgical knowledge has not fitted them to undertake, but which they may not have the courage to refuse when faced with the fact that both the profession and the public have come to regard these cases as belonging to the orthopedic field. Against this danger, which is by no means imaginary, about the only safeguard I can see is conscience and individual honesty. Nothing would more certainly bring our specialty into deserved contempt than such weakness on the part of those who practise it as would tempt them to venture beyond their depth. The justification of surgical specialties lies in the fact that devotion to a limited field should provide the patient with wider experience and greater skill than can be offered by general surgery; and the specialist who weakly permits himself to attempt cases which he is not better equipped to handle than the average general surgeon, not only violates justice and humanity, but brings discredit upon the specialty which he should aim to honor and adorn.

The second danger lies in the fact that military orthopedic surgery, comprehensive as it is, is by no means representative of civil orthopaedic surgery; and many a surgeon who could do the most difficult bone-grafting operation with consummate skill might find himself floundering discreditably in his attempt to treat cases of scoliosis, infantile club-foot, the disabilities resulting from infantile paralysis, and many of the tedious tubercular bone and joint conditions which demand the illimitable patience and mechanical resourcefulness of the older school of orthopedic surgeons.

It is the plain duty of those specialists who most truly embody in themselves the best elements of the orthopedic surgery of the past, together with its more modern developments, to guard against these dangers; and unless this Association be careful, not only to keep step with progress, but also to preserve the best of those traditions of our specialty which have come down to us from the times of Sayre, and Thomas, and Taylor, the line of demarcation between orthopedic and general surgery will in time become almost indistinguishable: then we will find history repeating itself—a new generation of orthopedists will arise who will revive the half-forgotten but indispensable mechanical aspect of this specialty.

The solution of some of the difficulties which lie ahead will almost certainly be found in the further development of the Orthopedic Section of the American Medical Association, and of local and inter-urban

orthopedic clubs. Both of these agencies have already proved their worth and will more and more contribute to the evolution of orthopedic surgeons of the highest type; and toward them the American Orthopedic Association should maintain a thoroughly sympathetic attitude. At the same time it must be frankly recognized that this Association will be unworthy, both in character and achievement, unless it become the embodiment of both the best traditions and the highest ideals of our specialty; and inasmuch as the character of the Association must be determined by the character of the individuals of which it is composed, it is imperative that the standard for future admission to membership be such as shall make the Association really representative of the modern conception of orthopedic surgery.

I have been slow to reach the conclusion that our standards for admission to membership must be raised, for my sympathies lie with those who seek opportunity to develop themselves. In the past, when conditions for admission have been debated in our executive sessions, I have stood in opposition to proposals which would make the attainment of membership more difficult, because I felt that one of the chief functions of the Association was to foster the development of those who were striving to perfect themselves in the work of our special field, and I had repeatedly seen very unpromising raw material develop incredibly within a few years in the favorable environment which this Association provides. But we must not be blind to the fact that conditions have changed to such an extent that the orthopedic surgeon of the future can neither adequately represent our specialty, nor meet creditably the demands which will be made upon him unless he be conscious of possessing wide general surgical training and experience. Consequently, for the sake of our members themselves, as well as for the welfare of the Association and of the public, it seems to me the time has arrived when no applications should be considered unless the candidate has been admitted to Fellowship in the American College of Surgeons, or one of the Royal Colleges of the Old Country. Both as individuals, and as an Association, we must not forget that, as in other spheres of human activity, what we achieve depends chiefly on what we demand of ourselves and our circumstances.

"I bargained with Life for a penny,
And Life would pay no more
However I begged at evening
When I counted my scanty store.

For Life is a just employer,
She pays you what you ask,
But once you have set the wages,
Why you must bear the task.

I worked for a menial's hire,
Only to find, dismayed.
That any wage I had asked of Life,
Life would have paid."

An event of outstanding importance during the past year, and one which means much to the future development of orthopedic surgery is the formation of the British Orthopædic Association, and it is a matter for sincere congratulation that our JOURNAL is now the official organ of both of these Associations, the true fraternity between which has been permanently cemented through elements of comradeship incidentally arising out of the war. The American Orthopedic Association extends most cordially the right hand of fellowship to this newly born organization, whose credentials are guaranteed by the fact that it is British. It was my expectation, until a few weeks ago, to welcome to this meeting the most distinguished member of the British Orthopædic Association, one whom we have all learned not only to admire, but to love, the Gamaliel of the orthopedic world, to whom all orthopedic surgeons make pilgrimage that they may sit at his feet and learn,—Major-General Sir Robert Jones. His services to the cause we represent can never be over-estimated, and with unfeigned respect the members of this Association look up to him as a Master. Our disappointment in not having him with us as we expected is tempered somewhat by the knowledge that it was his loyalty to duties growing out of the war which kept him at home.

It is impossible to look into the faces of this assemblage without being painfully reminded of the fact that two of our most respected members, who for many years have been regular attendants at these annual gatherings, and who were with us one year ago, will never more be seen in our midst.

"Death, a necessary end.
Will come when it will come."

Our late treasurer, Dr. G. G. Davis, was most devoted to his work and died in harness. He will be greatly missed, but his genial manner and

kindly unostentatious character will long remain a grateful memory to those whose privilege it was to know him. At my request Dr. H. Augustus Wilson had consented to present to this meeting a brief obituary of Dr. Davis; but alas! he too has fallen by the wayside. His keen, thoughtful mind and sound judgment will be greatly missed in the counsels of this Association, but the knowledge of his busy, useful life and the memory of his merry smile and generous, kindly spirit will not soon depart from our midst. Both were good men and true: "Their works do follow them."

A NOTE ON POTT'S DISEASE AND ALBEE'S SPINAL GRAFT.*

BY G. R. GIRDLESTONE, F.R.C.S., CAPTAIN, R.A.M.C.T.,
Hon. Surgeon, Baschurch. In charge Orthopædic Centre, Oxford.

As the treatment of Pott's disease by Albee's operation is not yet widely practised, it is felt that some statement may be made of our experience at Baschurch, with reference to a list of 50 consecutive cases.

It is with the approval of Colonel Sir Robert Jones, to whom, with Miss Hunt, the superintendent, the credit of the work done at Baschurch is due, that this note is being written; and it deals with cases operated on by him, Captain Aitkin, Captain Dunn and myself.

The diagnosis is based on the usual symptoms, special stress being laid on the presence of muscular spasm resisting movement in all directions, and x-ray findings.

The following points will be dealt with:

1. The special advantages of the operation.
2. The choice of case.
3. The pre-operative treatment.
4. The preparations for, and the technique of, the operation.
5. The after-treatment.
6. Table of cases.

* A paper read before the British Orthopædic Association, July 26, 1918.

THE SPECIAL ADVANTAGE OF OPERATION.

The main idea of the operation is that of fixation of the affected vertebrae with those above and below by an autoplastic graft from the tibia, and is based upon the possibility of controlling all movements of a section of the vertebral column by immobilization of the spinous processes.

In every movement of the spinal column the relations of the lateral articulations, bodies, and spinous processes of the vertebrae are involved, and in all, the lateral articulations provide an axis of movement, or, if the spines are fixed, a fulcrum for resistance to movement. If, then, the spines can be absolutely fixed, and the lateral articulations are sound, no movement of the bodies can take place.

One of the main conditions predisposing to continuance and aggravation of the disease is movement of the diseased bones, especially when it involves gradual crushing of the bodies of the vertebrae.

The vertebral column is built up in such a way that there is no locking or automatic stability in any position, and the immobility of the joints depends entirely on muscular tone and balance.

While there is a strong and efficient muscular control of the spine behind in the erector group, there is no such specialized group in front —the balance is kept up by the musculature of the thorax and of the abdomen, with its varying tension and action. In the erect position and during locomotion, weight and the shifting centre of gravity also tend to upset the balance, but these are factors which can be eliminated during bed treatment. Their importance becomes very great, however, when the patient is allowed to get up. Then comes a severe test of the bony healing, which may bring increase of curvature, and recrudescence of the disease.

The value of Albee's operation is great in that it tends to give:

(1) Permanent immobility in the corrected position.

(2) A greatly reduced period of confinement to bed.

(3) A safeguard against recrudescence of disease.

THE CHOICE OF CASE.

In our opinion, the operation is of great benefit in *all cases* of unhealed tubercular disease of the vertebral bodies, where there are no contraindications. Especially is it of value in cases where recrudescence tends to occur after prolonged periods of treatment. As to contraindications we consider:

(1) *Age*. There are no definite limits, but at present we prefer not to operate before the age of three years. On the other end of the scale

the general condition or the activity of the disease, etc., may preclude operation.

(2) *Position.* Disease of the atlanto-occipital and atlanto-axial regions is not readily amenable to a graft operation.

(3) *State of Activity.* We prefer not to operate while the disease is in the more active phase. The cases are kept immobilized on frames until signs of activity abate.

(4) *Sepsis.* We look upon the presence of a discharging sinus, or any other septic focus, on or near the site of operation, as a definite contraindication.

(5) *The Question of "Cold Abscess."* An unopened psoas or lumbar abscess is not a contraindication, provided it is not necessary to operate *through* the abscess. We have not operated through such an abscess, but in cases reported from other sources abscesses have been opened at an operation, with harm resulting.

Unopened abscesses are left unless:

(*a*) They are enlarging and tending to point, when they are emptied by aspiration, or a small incision and suture, without lavage or any interference with the sac; or

(*b*) There are signs of secondary infection, *e.g.*, associated with high temperature, when the abscess is opened, washed out, and sutured, drainage being avoided whenever possible.

THE PRE-OPERATIVE TREATMENT.

Immediately upon detection of active Pott's disease treatment is begun. This consists in:

(1) *Splinting.* This generally consists in the use of double Thomas frame, but in special cases plaster of Paris is used. It is designed to give complete rest to the diseased parts.

(2) *Reduction of Deformity.* The method of reduction of deformity, where advisable, depends on the site of the lesion. We attempt to get rid of the "reducible" deformity by very gradual means.

(3) *General Treatment*, including good feeding, open air, warmth.

The cases are nursed in long huts, with a floor, one side, two ends and a roof; they are kept warm with sufficient blankets and hot water bottles.

For the description of the methods of splintage it is convenient to take the cases in regional groups, taking the largest group first.

(1) Mid dorsal, low dorsal, dorso lumbar, high lumbar.

(2) High dorsal, cervical.

(3) Low lumbar.

(4) Lumbo sacral.

FIRST GROUP. MID DORSAL, LOW DORSAL, DORSO LUMBAR, HIGH LUMBAR.

(*a*) *Immobilization.* These cases are treated entirely on the double Thomas' spinal frame. This is fitted accurately to each case. The saddle, which should be thick, moderately soft, and evenly padded, should lie from the first or second thoracic vertebra to the tip of the coccyx, and its legs should reach to the middle of the popliteal space. The saddle is loosely attached to the frame, so that it may be slid up and down for an inch or two. The main posterior bars of the frame must be made of ample strength and rigidity; the lateral bars should be strong enough to retain the position given them by the use of a wrench.

Where there is no marked kyphos, the patient is placed carefully and directly on the frame, the fold of the buttocks coinciding with the antero-posterior bend of the frame, and the saddle being adjusted as de-described above, so as to allow nursing facilities. Where a marked kyphos or any projection is present, it is fully protected with thick felt accurately cut; of this several layers may be necessary. The legs are wrapped warmly in cotton wool, and a straight gutter splint runs from the mid thigh to the mid leg, with a thick pad under the knee. Any danger of *genu retroversum* must be avoided. Except in cases of dropped foot or spasm we do not like puting right angle splints on the feet, as they prevent movement of the ankle, which is the only joint of the leg which the child can move with impunity. The body bars are bent round the abdomen and chest. The bend should commence fairly sharply, and as far back as possible, so as to lift up the sides of the saddle and thus provide some lateral support against movement. The neck straps are tied across the chest, after passing diagonally through the holes in the ends of the chest bars.

Fixation of the legs by extensions, with groin strap counter extension, is very rarely needed, and then only in the case of troublesome patients.

Turning. For the purpose of turning the patient without fear of movement, a plaster cast is made as follows:

An old blanket, or similar piece of material, is spread over the body from the chin downwards and is split to cover the front and sides of the thighs and legs. Plaster bandages are then run over this in all directions, until the plaster cuirass is complete. For adults it can be strengthened by incorporating light iron bars in the plaster in the hip region. The cuirass is now removed, and set aside for a day or two to dry.

When in use, the chest and neck are protected with wool, etc. The sides of the frame are bent outwards, so as to be below the level of the chest and abdomen: the bandages are taken off the legs, and the cuirass put in place. Straps are placed under the frame and round the cuirass in the region of the chest, abdomen, thighs and legs. When the turning team are quite ready these straps are pulled up tight, fixing the cuirass and frame together with the patient held firmly between them.

Of this team:

One is to stand at the head to manage the head and arms;

One to stand at the bottom, to take the cross bar of the frame and to see that when the patient is lowered the toes project over the end of mattress or table.

The others are to place their right hands under the nearer bar of the frame, and their left hands over the body and under the further bar. Then, at the word "lift," they all lift together, and at the word "turn," roll the whole frame over into their right arms; at the word "lower," lowering it onto the table or bed.

The straps are immediately loosened, and the frame lifted off the patient. The dressing of the wound can now be done at leisure and the splint cleansed and freshened.

The straps are not removed, and when all is ready, the frame, splints, etc., are reapplied, and the process reversed.

This is now almost the invariable method of turning these cases; it is invaluable in preventing any movement. After grafting, this control is especially helpful as one is not afraid to turn the patient as often as may be indicated, for dressing the wound and re-applying the special protective padding.

Apart from this formal turning, no movement whatever is allowed. The lower part of the frame is lifted by the bar for nursing purposes. As regards washing, the nurse washes only what she can see.

In all cervical and dorsal cases the frame has a head-piece, and it is important that the head should be allowed to rest right back on this, and not be propped up on pillows, so as to keep up the tendency to extension in opposition to flexion of the spine. At Baschurch the tedium of this position is much relieved by the use of a hand looking-glass fixed on the end of a stick as a periscope.

(*b*) *Reduction of Deformity.* The practice is to promote gradual correction by the influence of gravity; the frame is flat, the head-piece low, and the thickness of felt surrounding and protecting the kyphos is lessened every few days. In applying this felt the layer near-

est to the kyphos is cut crucially, so that the prominent angle is protected from the weight-bearing pressure; this is taken just on each side of the spine, and immediately above and below the kyphos. The next layer is cut similarly, but on a larger scale, and so on. The result is, that while there is a concentration of body weight in the region of the kyphos tending to reduce the deformity, yet there is protection for the skin over the angle. As the straightening occurs the number of layers is reduced.

By this treatment, what may be termed the reducible deformity is got rid of, but in many cases a certain fixed deformity remains.

SECOND GROUP. HIGH DORSAL AND CERVICAL.

(*a*) Splinting. In these cases, plaster is often found more effective in immobilization than the frame. The casing begins with a firm grip of the pelvis, and is carried up to include the head. An elastic cotton net vest is worn next the skin, and over that felt, with careful protection of the prominent region. This is applied in as much extension as can be obtained without force.

In other cases, a frame and head-piece, with the saddle carried up on the neck, coupled with a plastic cuirass, including the neck and sides of the head, is used. In making this cuirass, it is necesssary to insert temporary pads to protect the lines of the neck.

A second cuirass, firmly controlling the chin, and including the legs, is used for the formal turning.

The headpiece has the leather well hollowed, so that the head beds down comfortably into it. The head is then fixed to the headpiece with a collar made of strong paper and muslin round the forehead.

(*b*) *Reduction of Deformity.* This is accomplished, so far as possible, by a series of such plasters.

When the frame is used it is achieved by altering the lie of the headpiece slightly each time it is removed, after "turning."

THIRD GROUP. LOW LUMBAR.

Both for this group and the next, a frame is not so satisfactory as plaster, in that the pelvis is not controlled so completely. For this group the plaster jacket includes the trunk and one thigh.

FOURTH GROUP. LUMBO SACRAL.

Here it is necessary to include both thighs in the plaster. As there is usually lordosis, it is advisable to correct this as far as possible by

flexing the thighs on the trunk, and then to put on the plaster in the position of moderate flexion. Later, by controlling the pelvis and spine, the limbs can be extended.

(4) *The Operation.* This need not be described in detail. We attach importance to:

(*a*) The use of ether rather than chloroform.

(*b*) The warmth of the theatre and the table.

(*c*) The complete avoidance of hammering, except the few taps necessary for the conversion of the drill holes into transverse cuts in getting the graft from the tibia.

Lately I have preferred not to use a tourniquet for the leg. It is necessary to note carefully the length of the spinous processes, as over a kyphos they are often much shortened, and there is a real risk of opening and so possibly injuring the cord by cutting down too far. We take great care to prevent any movement of the spine during the operation as this might well lead to reactivity, a dissemination, of the disease.

POST-OPERATIVE COMPLICATIONS.

(1) *The Development of Pressure Sores.* This is almost always avoidable by accurate padding. If they occur the patient is turned every other day.

(2) *Protrusion of One End of Graft.* Possibly due to insufficient suturing. In one case this happened: the end was cut off and the wound resutured, with ultimately good results.

PO-T-OPERATIVE TREATMENT.

Immediate. During the first few hours, treatment for shock is indicated.

Later. Dressings. The first dressing is done 4, 7, or 10 days after the operation, the period depending on the presence or absence of such indications for early dressing, as discomfort, sharp bony prominences, or poor nutrition of the skin.

For the dressing, the employment of the cuirass is specially indicated, with, in the case of adults, a team of lifters drilled in its use. At each dressing, the arrangement of the protective padding round the graft areas should be done by the surgeon himself. It must be very thick, and so disposed that the weight is off the operation area, and on broad areas above, laterally, and below.

The patient is turned about once a week to refresh the protective padding, which flattens out amazingly.

Removal of Frame. In all cases of Group 1, where a strong graft can be placed firmly in position in strong spines, and where the angulation is not great, the frame is changed for a light spinal support (Jones') at the end of three months. The patient lies in bed in this for another month, and is given massage to restore muscular tone. He is then allowed to sit up in a chair, and soon to walk. He wears the support for a year.

In the other groups, light plaster jackets are used instead of the spinal support. In low lumbar and lumbo sacral cases, the plaster is carried down to the middle of one leg. In a month's time the leg is freed, later the thigh.

In younger children where the graft is not strong, and in cases where the spines are short, or angulation marked, six months or more in bed are required, the spinal support is kept on for more than a year and only left off gradually under supervision.

(6) *Records of Cases.* A table of cases, giving the results so far as I have been able to ascertain them, is appended.

In one case laminectomy was necessary, the graft was afterwards placed in position so as to bridge the gap and unite two spines above and two below. I have done this in other cases and am convinced that a tibial graft is a most helpful accompaniment to a laminectomy whether for tubercle or other indications.

It may seem that undue emphasis has been laid on the pre- and post-operative treatment; but we feel that while the operation is in some cases the deciding factor in attaining complete immobilization, and always most effective in shortening the period of confinement to bed, its success depends on the efficiency of the associated treatment. During this period the operation is added to, but in no way a substitute for, the regular treatment. *The graft is only an effective splint when firm bony union is attained.*

Owing to pressure of work I have been unable to refer to the literature of the subject; this I much regret.

I wish to express my gratitude to Captain Morris, R.A.M.C., for his aid in collecting the material, and to Miss Hunt for her help in the general descriptions of the pre- and post-operative treatment customary at Baschurch.

Finally, to Colonel Sir Robert Jones, Captain Dunn, and Captain Aitkin, for allowing me to include their cases.

Patient's Name	Age at Date of Operation	Date of Operation	Surgeon's Name	Position	Present Condition so Far as Ascertained	If Still Wearing Support
Gilbert W.	14 years	Feb. 9, '13	R. J.	D. 5 to 7	Last heard of enlisting.	No
Lillie W.	35 "	March 8, '14	R. J.	Dorso Lumbar	Has occasional pain.	Yes
Jane D.	24 "	March 22, '14	R. J.	Lumbar	No pain. Works from 8 A.M. to 6 P.M. Walks 6 miles.	Yes
Annie B.	25 "	May 6, '14	R. J.	Lumbar	In regular work. No pain	During work only
James M.	34 "	May 6, '14	R. J.	Dorso Lumbar	Bed-ridden.	Yes
Mrs. Moon	28 "	May 6, '14	R. J.	Dorso Lumbar	Was doing well. Has since died of pneumonia.	
Wilfred N.	4 "	July 27, '14	R. J.	Lower Dorsal	"Quite a normal small boy."	No
Edith J.	6 "	May 9, '15	R. J.	Lower Dorsal	Can walk fairly well. No pain.	Yes
George P.	25 "	Aug. 22, '15	R. J.	Dorso Lumbar	Working as chauffeur. No pain.	Yes
Charles T.	34 "	Oct. 24, '15	R. J.	Mid Dorsal	Doing light engineering work. Can walk 4 miles. Slight pain.	Yes
Violet R.	7 "	Dec. 15, '15	Capt. G.	Low Dorsal	Going regularly to school. No pain.	Yes
Ada B.	10 "	Feb. 20, '16	Capt. G.	Low Dorsal	Can run and jump. No pain.	Yes
George C.	4 "	March 13, '16	Capt. A.	Dorsal	Can walk well. No pain.	Yes
Jack R.	10 "	April 30, '16	Capt. G.	Dorso Lumbar	Walking very well. At school. No pain.	Yes
Eddie D.	12 "	May 8, '16	Capt. A.	Lower Dorsal	Working in factory. Plays football. No pain.	Yes
Irene C.	6 "	June 11, '16	Capt. D.	Low Dorsal	Runs and walks any distance. No pain.	Yes
Kitty C.	14 "	June 25, '16	Capt. G.	Upper Dorsal	Died June 29, '16. Hyperpyrexia. Clear brain. Wound appeared perfect.	
George R.	12 "	July 10, '16	Capt. D.	Upper Dorsal	At school. No pain.	Yes
May B.	12 "	Aug. 13, '16	Capt. D.	Dorsal	Walks 5 miles. No pain.	Yes
Albert C.	9 "	Oct. 29, '16	Capt. D.	Dorso Lumbar	Walking fairly. Very delicate boy. No pain.	Yes
Violet D.	9 "	Nov. 5, '16	Capt. A.	D. 12-L. 2	Can walk 2 miles. No pain.	Yes
Sam R.	5 "	Nov. 19, '16	Capt. G.	Upper Dorsal	Doing fairly well. No pain.	Yes
Charles T.	4 "	Nov. 27, '16	Capt. D.	D. 7 to 9	Going to school. No pain.	Yes
Hilda T.	10 "	Dec. 31, '16	Capt. A.	C. 4 to 5	Can walk a long way and goes to school. No pain.	Wears Collar
Stanley G.	6 "	Feb. 25, '17	Capt. A.	D. 3 to 5	5 months after operation developed general T. B. Died.	

Patient's Name	Age at Date of Operation	Date of Operation	Surgeon's Name	Position	Present Condition so Far as Ascertained	If Still Wearing Support
Clifton C.	3 "	March 11, '17	Capt. D.	D. 6 to 7	Can walk half a mile. No pain.	Yes
Winnie B.	5 "	April 23, '17	Capt D.	L. 3 to 5	Walks well. No pain.	Yes
Walter H.	5 "	April 28, '17	Capt. A.	D. 8 to 10	Walking well and goes to school. No pain.	Yes
Tom W.	4 "	May 6, '17	Capt. G.	Mid Dorsal	Can walk. No pain. Health very very much improved.	Yes
Horace M.	3 "	July 13, '17	Capt. D.	D. 8 to 12	Walking well. No pain.	Yes
John G.	4 "	July 23, '17	Capt. A.	D. 10-L. 1.	Doing very well. No pain.	Yes
Horace R.	7 "	Aug. 13, '17	Capt. D.	D. 3 to 10	Walking very well. No pain.	Yes
Charles J.*	17 "	Aug. 26, '17	Capt. G.	Dorsal	Regained full sensation. Died during hip reduction under anaesthetic Aug. 4, '18.	
Private T.	31 "	Oct. 7, '17	Capt. D.	D. 12-L. 1	No better. Still in bed.	Yes
Jack C.	9 "	Oct. 14, '17	Capt. A.	D. 4 to 8	Walks well. Very delicate. No pain.	Yes
Horace B.	18 "	Nov. 4, '17	Capt. D.	L. 1 to 2	Walking well. Working. No pain.	Yes
Albert O.	9 "	Nov. 11, '17	Capt. A.	D. 1 to 4	Not yet up on account of temp. and spasm. Much better.	Yes
Pensioner G.	26 "	Nov. 18, '17	Capt. G.	Low Dorsal	Walking well for an early case.	Yes
George O.	4 "	Nov. 25, '17	Capt. G.	D. 8 to 11	Walking well.	Yes
Doris W.	4 "	Dec. 3, '17	Capt. A.	C. 6-D. 2	Walks very well indeed.	Yes
Ralph H.	9 "	Jan. 6, '18	Capt. A.	Mid Dorsal	Walking well.	
Gladys L.	12 "	Jan. 13, '18	Capt. G.	Low Lumbar	Walking well in plaster with one hip fixed.	
Lizzie S.	5 "	Jan. 27, '18	Capt. D.	Dorsal	Died, evening Jan. 27, '18, with hyperpyrexia. p. m. Spines extremely short, graft in contact with cord.	
Maria T.	11 "	Feb. 10, '18	Capt. G.	D. 12-L. 1	Doing well. Off frame, in back support, but not walking yet.	
Robert W.	9 "	Feb. 17, '18	Capt. A.	D. 8 to 12	Doing well. Still on frame.	
Miriam C.	8 "	March 10, '18	Capt. G.	L. 1, 2, 3	Doing well. In back support. Not up yet.	
Horace W.	13 "	April 7, '18	Capt. G.	L. 1 to 4	Still on frame.	
Douglas A.	9 "	April 21, '18	Capt. D.	D. Lower 6	Still on frame.	
Sydney M.	6 "	May 19, '18	Capt. D.	L. 4 to 5	Still on frame.	
Pensioner S.	20 "	June 23, '18	Capt. A.	L. 3 to 4	Still on frame.	

* Graft combined with laminectomy for complete sensory and motor paralysis.

DISCUSSION.

THE PRESIDENT: This is a record of very good work, and it is a very interesting paper. In the list of cases put on the screen, I notice that one of the patients afterwards played football, which is a good proof of the stability of the scar. I hope we shall have a good discussion on the paper.

CAPT. MCCRAE AITKEN: I think we must congratulate Mr. Girdlestone on his paper. His description of the technique, especially of the preparation beforehand, and the after-treatment, is very important. There is no doubt whatever that the bone-grafting operation, both for tubercle and for certain cases of fracture, is one which will remain in the routine armamentarium of the orthopedic surgeon.

I came in late, and therefore do not know if he laid emphasis on one particular operation in which he performed laminectomy first, to relieve pressure on the cord. (Mr. Girdlestone: Yes.) That case I have seen and it is one which has been exceedingly interesting to me. We are all familiar with those cases of caries of the spine in which an apparently satisfactory convalescence is interrupted suddenly by an impairment of facility in walking, by an increase in the knee jerks, and by that varying quality of the Babinski sign, the extensor plantar reflex. I do not know whether Mr. Girdlestone laid down any definite rule as to when laminectomy should be performed. My own experience in such cases has been that those in which there are merely motor disturbances generally recover, but in those cases where, in addition to interference with the reflexes, there are sensory disturbances, there has been a fatal termination. And in such cases, following on what I have seen of Mr. Girdlestone's case, I should be prepared, in future, to at once perform laminectomy, even if I had not yet got that spine sufficiently straight to satisfy me that the best time for performing the Albee operation had arrived.

With regard to the points of technique in the operation itself, there is no doubt whatever that the condition of the spine has been infinitely better since we have abandoned the use of the hammer and chisel. There was almost always a certain amount of shock during the process of splitting spines with hammer and chisel, and the difference in the condition of the children two hours after the operation is so great that I do not think there can be any question on this point. The great difficulty of estimating the depth of the curve of the spine, is one which always faces us. I am, personally, very shy of using a saw with any force over the summit of the deformity, because as a rule there is a very short spine in that region. I content myself, therefore, with simply nicking the spine in those cases, and, as Mr. Girdlestone has pointed out, complete the severance with the chisel and split open the spine. The point is to get the raw bone area, the layer of muscles and ligaments over the graft, with subsequent suturing. Mr. Girdlestone's paper has dealt mainly with cases, mostly civilian, performed at Baschurch, though some have been in soldiers. This operation has, of course, a place in military surgery, because we have had a fair number of cases sent in to our military hospitals with fractures of the spine, with increasing deformity, localised at the seat of injury at the back, with increasing caving in of the bodies due to inflammatory changes in the bone following injury by a bullet. These are to be treated by us, I think, as absolutely parallel cases to those of tuberculous caries. I have had in the last 18 months three cases at Shepherd's Bush, on which I have performed the same operation exactly as described by Mr. Girdlestone, with varying success. In one case, a considerable portion of the graft showed in the wound, and it looked quite white. In this, as in most cases of military surgery, I paid no attention to a graft that showed white in the wound: it is when a graft begins to go black that I do not like it. I think the white grafts granulate over, and the wound heals over them, and the bones in those cases subsequently become incorporated in the underlying bone, throwing off as a sequestrum only a portion of the scaly hard surface of the hard bone

of the tibia. I do not know whether others have had similar experiences; no doubt they have. All I have to say further is to thank Mr. Girdlestone for a very interesting paper.

Mr. W. H. Trethowan: I confess to having felt some disappointment over Mr. Girldestone's paper. It seems we have been discussing details, such as whether we shall use a hammer and chisel, and so on, and whether scars go white, or go black, and so, I think, we have got lost in details. The essence of the thing—and what I expected Mr. Girdlestone's paper to give us—is: Are the results of this Albee operation good? Do they warrant us allowing it to supersede the older methods of splinting? In essence, Albee's method is one of internal splinting, instead of external splinting. To submit a child with grave disease like tuberculosis to a radical and severe operation when it is not absolutely necessary is, to my mind, appalling. We have listened to Mr. Girdlestone's operative details, but he should remember we are not a collection of general practitioners, we are operating surgeons, and hence we know how to deal with operative details reasonably. I submit that it is a waste of time to deal with those things here. We should not discuss details of splinting, whether in the neck or in the lumbar region. We all know how to splint a case of spinal caries, or at all events we ought to. If there is employed the careful splinting which Mr. Girdlestone is forced to use, in addition to his operative measures, he should get success with those measures. To introduce an operation in this scheme of treatment seems to me unnecessary. We don't want to know about hammer and chisels; we want to know whether this method is any good, as compared with others, whether it contrasts favorably with the old splinting method. I have not done Albee's operation; I like, as much as anybody does, an operation where there is use in it, but this seems to be one of those useless procedures which we might call carpentry—I might use another term, but I will not now. To do an operation like that, merely for the sake of operating, to go into the workshop to play with hammers and other tools, is not right when we have got other methods which, apparently, we have to use as well, even though we do carry out this particular operation. I would like to know, from people who have had experience of both methods, whether the Albee method saves time, whether we are really warranted in subjecting a child to all this increased risk which is implied in doing this operation. I contend that the man who can use his hands properly ought to be able to splint up a back. We also know how to take casts, how to make nice jackets, we can splint them up and then immobilize them in that way. A year ago I asked Sir Robert Jones himself: I said to him, "Do you save time by operating on children by the Albee method?" He said, "No, I do not think we do at all." He may of course, have changed his opinion since. What I want to know, therefore, is when people do Albee's operation, when they tinker with hammers and chisels in that way, do they save time? I do not think so. If these children are splinted properly, they do very well, and I think that is all that is needed in the general run of cases. Does this save time?

The President: That, I think, is the point to discuss, the other matters are beside the question.

Mr. Bennett: I was somewhat in the same mental attitude towards this operation as that which Captain Trethowan has expressed. I went over to America to see what they were doing there. I saw Albee doing it. I did not bring his apparatus. It was in 1913. I, however, evolved something which would take its place, that is, some other apparatus. It was in the form of a circular saw, and I started doing the operation on his lines. I could probably follow the technique of Mr. Girdlestone pretty accurately, because it was definitely laid down by Albee. I have now done it in about one hundred cases, so I have had the opportunity of seeing what the results are during the past five years. In children I have not, so far, had

a fatal case. One, of course, loses sight of some cases. But I can tell Captain Trethowan that in the majority of the cases we have saved the child patients two years, because the treatment of spinal caries takes three to five years. I think we are agreed as to that fact. Yet after this method I have seen children, after nine months, playing about with other children as if they were normal. I do not say that happens in every case; much depends on the type of case. But a sturdy little boy, full of *joie de vivre*, who will not keep quiet, will do that, and I have been astonished to see the results. I think I can reassure Captain Trethowan that you can definitely save time by this operation. The further question is, is it, apart from the time saved, worth the danger of doing it? Is it a dangerous operation? No, it is not. It is a simple operation, much simpler than Hibbs' operation, which at first was regarded as a simple procedure and requiring only one incision. But afterwards I found that that one incision involved so much manipulation that I came to the conclusion that Albee's was a much simpler operation. I have tried to simplify the operation in this way: I have many children to deal with, and I have two or three cases in a morning, so that I can take away what I require; I can split the tibia into three pieces, and give each one of them a small piece, so that instead of six operations it means four, and it is so much better for the child whom you have relieved of the tibial part of the operation.

With regard to the after-treatment, I take it in this way. The bone takes eight weeks to unite, and I give them another eight weeks to make sure of good union. But it is not really the bony part which matters so much. I think the part we are apt to neglect is the fact that we bind muscles and fascia over that. And beyond the purely osseous portion, between spine and graft you have all that fascia bound down by strong kangaroo tendon, which I pull very firmly. That is one of the most important elements in this operation; it is, I feel, a very important factor. When I have had a fairly strong case, which I felt I could operate on with safety in this way, I have taken a double graft from his spine, and taken the remainder to another hospital to put into another patient, without in any way inconveniencing the patient who has been operated upon and who has given the grafts. In giving grafts to children from adults—I have chosen that when I could—I have never seen the graft come away from the child. In the whole of the time I have mentioned, I have only seen four grafts drop. One was in a boy aged 18, and that graft was wrongly taken. I stripped the periosteum. If you do strip the periosteum, there is a likelihood of the graft dying; therefore in doing this operation, be very careful of the periosteum. I would like to hear the opinion of Mr. Girdlestone and others on that point, because it is only by relating our experiences that we can be helpful to each other in that way.

Captain Platt: I thing Mr. Trethowan's homily was a timely one, although I do not agree with him in all he said. It would be impossible to establish, by a series of statistics, the superiority of Albee's operation over the ordinary conservative method; at any rate it would be difficult to prove. But from a general impression of the results of this operation, I think certain facts have been established.

In the first place, with reference to tuberculosis of the spine in adults, this operation is not only desirable, but one feels it is urgently needed, and those are among the most brilliantly successful cases. Then again, in very young children—those under five years of age—this operation is certainly undesirable. But in the ordinary child with a tuberculous spine, and perhaps especially in the case of the child who has to be treated in the city out-patient department, any operation which has been proved—as this has—to shorten the period of treatment is an operation to continue to perform.

Another point to remember is, that the conditions at Baschurch where Mr. Girdlestone's operations have been done, are ideal: the patient has come to this hospital, which is in a country district, some time before the operation is to be undertaken, and the after-treatment is carried on under the same

exceptionally favorable surroundings, therefore the functional results should be of the highest order.

Captain Winnett Orr: I have seen a good deal of both methods of treatment. There is a definite field for the Albee operation. Having done it a few times, and having stood by the table while Albee did it a few times, I will venture the opinion that the operation is justifiable. I am betraying no secret when I say it is possible for children with Pott's disease to recover in from six to nine months. We have seen them recover entirely useful backs in less than a year. For a patient under the Albee treatment to recover in 6 to 9 months is not regarded as in any way miraculous. In an experience of 300 cases of Pott's disease I have done the operation on my own cases three times, and I have regarded it as often enough. In some cases, especially in adults, where there is persistent delay in recovery under the conservative methods of treatment, the fixation of spine which may be secured, especially where there is involvement of two or three vertebrae, by the Albee operation is desirable, as it contributes to shortening the period for recovery. But I have rarely seen cases in children under five or six years of age in whom I felt the operation was at all justifiable. The operation is, after all, a comparatively simple one, and yet every report read on this subject betrays the fact that there is a risk, because some of the patients never recover. To reduce the cases in which the Albee should be done to the mimimum is better than becoming enthusiastic over the operation, because in the latter case you will be liable to do the operation a few times too often.

Mr. McMurray: I have had some experience of the Albee operation. I have 250 children in one hospital with tuberculous spine, and 150 cases of tubercular diseases of bones and joints. We have, there, the best open-air hospital in the world. These cases are treated out of doors all day and all night; they have only been inside on five nights for a period of five years. The chief surgeon there is Sir Robert Jones. Sir Robert Jones brought this treatment to Baschurch; we did it there, and we stopped doing it; it may be that we were wrong in stopping it, though I do not think so. There is only one kind of case in which it is the ideal operation, and that is in the adult, and especially one with affection of the lumbar vertebrae. You cannot fix the lumbar spine in an adult by splinting, it can only be done by means of graft. To go and operate on every child who has a tubercular spine is to do the kind of thing which brings orthopedic surgery into disrepute; it is apt to bring about that state of mind which leads people to say "These hospitals should be shut." When we have cases in the out-patient department we know when we have fixed them properly on the frame that they will not develop abscess, or paraplegia, or loss of control of bladder or bowel, but that they will go on and become perfectly well as a matter of course. They all do; it is not a question of one here and there doing so. And the cases in which this Albee operation has been done have to be treated in exactly the same way afterwards; support must be kept up for at least six months, and there has been pain in the legs after operation. I have seen a dozen cases operated upon by the Albee method in which pain has been experienced in the legs after the patient has been running about, although the child had had six months' rest after the operation, so that it was necessary to put the child back on the frame. This operation may save three months, but that is nothing to a child with tubercular spine. I should like to know from Mr. Girdlestone why he put the child in the frame and then had a little felt with a hole in its centre, and gradually took that away. The reasonable thing is to gradually put the felt in. You have that fall to the back of the frame and gradually push the spine up again until you get hyperextension; that was the idea of the felt,—to raise the spine up, and let the shoulders and pelvis fall down, then there will be a straight back. But you cannot get that on an ordinary frame. He also described how you put a plaster jacket on. The simplest way is to put the child on to its face,

with its head over the edge of the table, and cover the child with the jacket to its heels, make the plaster, and mould it to half the body over its whole length. Then take the plaster trough off after it dries, and when dry it will be the exact shape of the child, and by putting layers of felt into the space you can raise up the spine again, and so obliterate the curve. This leaves the front of the chest free, so that the child is much more comfortable.

MR. GIRDLESTONE, in reply: Captain Aitken, in the course of his kind remarks, mentioned laminectomy and the indications for carrying it out. I am not in a position to lay down any rules at all about it, because I am here to learn. I merely made a statement as to what I have learned at Baschurch; the paper is not a setting out of what I am trying to teach. But I agree with what has been said about laminectomy, that it is only exceptionally needed, and then when sensation is involved, especially when the sphincters are affected, because the experience is that those cases generally get worse. After this operation, however, as you will have seen by the charts I showed, indicating the return of sensation, and the function of the sphincters, the laminectomy has been perfectly successful, and the patient is getting well.

In reference to Mr. Trethowan's remarks he asked why the paper was inflicted upon him. I ask him to raise that question with Captain Platt. His second question was as to whether the operation shortened the period of treatment. I tried to make that point clear in my paper, but, apparently, I did not succeed. The great theoretical advantage of the operation is, that the splint stays with you. If you have bony union of a strong tibial graft to the spinous processes of the vertebrae, there is no tendency for a crushing action due to the weight of the body; you have got a spine perfectly splinted, and I think that is the important point. Certainly the child who has had an Albee done stays a less time in bed. If you take a case of tubercular caries and operate upon it, it is up in four months if it has no marked kyphos, and a strong spine where you apply a strong tibial graft. We have had no signs of recurrence in these cases. Under other circumstances, however, you could not, with safety, get that child up under a year or even 18 months.

The other point is, that that is not the kind of case for which the operation is most needed. The case it is most needed for is that in which the other treatment does not yield good results. If the child gets apparently well on a frame, is got up, and there is a relapse, then the Albee graft is done, and after that, when the child is got up, the condition does not come back again, at least there has been only one instance in which it did come back. But the main point is, that with the Albee you take your splint with you, and when the patient gets up, the bones are not subjected to a crushing action.

The third factor in the argument concerns the time element. I shall be glad for every member to read carefully the analysis of the fifty cases of tubercular caries on which my paper was based; the patients were up and about in one-third of the usual time; it shortens the bedridden period by two-thirds.

As to blue, black and white grafts, I think only one graft has been seen at Baschurch, and it was cut off. That was black. But that remark of Mr. Trethowan's may be regarded as a bit of poetic license.

Mr. Bennett remarked on suture of ligament over the graft. Possibly that is of value, but to procure bony union seems to be the main thing.

Captain Platt suggested that the operation is more valuable in adults than in small children, and with that I cordially agree. And I specially agree with what Mr. McMurray said concerning the lumbar spine. With the cases of lumbar spine and using a big graft, one gets an ideal result in a very short time. But I was surprised to hear that Mr. McMurray cannot control the lumbar spine by splinting. We use plaster of Paris, and, so far as I know, that controls the lumbar spine, though not for walking purposes.

INTERNAL DERANGEMENTS OF KNEE-JOINTS.

BY CHARLES F. PAINTER, LIEUT., J. G., U.S.N.R.F., CHELSEA NAVAL HOSPITAL.

THERE are two periods in young manhood when there seem to be an unusual number of injuries of the knee-joint which come under the heading of "internal derangements." These are at the two extremes of adolescent life. There is a notably greater incidence of semilunar cartilage displacements in the period of boyhood when football is first played as a part of organized athletics in public, high, and private school life. Boys at that age, if they are big and husky, are promising candidates for football teams, but are too poorly knit together to withstand the hard knocks of the game as it is played by young men in late adolescence, that period covered by collegiate training. This is noticeable in civil practice. On entering the service of the Navy I was quite surprised to find so many cases of semilunar and other knee-joint injuries among young men of from 20 to 24 or 26 years of age. On analyzing the cases it would appear that the greater incidence of these in this period and in naval service is due to the strenuous existence led by these young men and the traumatisms incident to the service and the athletic contests in which Navy men engage.

The more common injuries among these men are semilunar cartilage displacements, injuries to the bursa beneath the biceps femoris tendon just above its insertion into the fibula, and hypertrophies of the alar ligaments.

These lesions all give symptoms more or less alike so far as the subjective features are concerned. Their objective signs may not be notably different except in the case of the bicipital bursae.

The failure to discriminate between these lesions and simple traumatic ruptures of the lateral ligaments of the knee-joint or synovitis of the knee are often attended by consequences which may be more or less serious, is shown by one of the cases reported later on in this communication. In this case the diagnosis had been "undetermined" for several weeks and the patient had been returned to duty; he had fallen twice because the knee suddenly gave out under him and he was sent to the sick bay with a diagnosis of fracture of the humerus. On another occasion he dislocated a thumb in the same manner. He had been confined in the hospital, or away from duty because of "leave" granted after these injuries, for several months all told. This represented a distinct loss of service to the Navy Department and an ex-

pense for carrying this man the 14 months which had elapsed since the injury, most of which might have been avoided had the correct diagnosis been made when it was first possible to have made it.

Semilunar cartilage injuries are of two kinds. In one variety the ligamentous connection between the tibia and the face of the semilunar cartilage is torn away and the cartilage acquires a mobility which permits a catching in the joint at times, but seldom any locking of the articulation. Associated with this catch there is usually an effusion; almost always in the early repetitions of the catching. There is pain at the time and lameness, with a definitely localized tenderness along the line of the ruptured ligamentous connections with the cartilage.

This second class of cases is concerned, as is the above, with the internal meniscus of the semilunar cartilage in a great majority of cases, and besides having had the anterior ligament torn away, the cartilage has been fractured. As a result of this there is a free end of cartilage which flaps in and out of its normal position. This free piece may be detached from its anterior ligamentous connections for as much as an inch or an inch and a half. This break occurs at about the same place in all instances, *viz.*, at the junction of the inner and middle thirds of the internal meniscus. The free end sometimes turns up at right angles to the direction in which it normally lies and projects itself in between the femoral and tibial condyles where it becomes shredded by the traumatism of repeated crushes. This is observed more particularly in the old untreated cases. An inevitable effect of the looseness of this cartilage is injection of the synovia in the region traumatised, effusion into the joint, repeated with every redislocation, resulting at last in more or less thickening of the synovial membrane, and traumatism to and hypertrophy of the alar ligaments, causing an interference with the function of the joint from this alone. It is impossible to cause an injury which will tear or rupture the semilunar cartilage when the leg is fully extended unless it is associated with a fracture or dislocation of the knee-joint proper: the force which produces it must be delivered while the leg is flexed to some extent and the pressure exerted upon the outer side of the knee or the inner side of the leg, directed either inward, or upward and outward, as the case may be; if, when the foot is held immovably on the ground and the body turned forcibly outward, *i. e.*, in the reverse direction of the hands of a clock as regards the knee in question, and at the same time the leg is slightly flexed, the cartilage may be dislocated. Rarely the outer semilunar meniscus is dislocated and causes the same set of

symptoms referred to the outer aspect of the knee. This external dislocation is frequently associated with bicipital bursitis, the cartilage being found protruding into the bursa through the opening which so frequently connects the bursa with the knee-joint.

Given a history of injury to the knee-joint sustained in the manner above described, and especially if under similar provocation there is repetition of the initial symptoms of pain, effusion, disability, flexion deformity and tenderness referred to the internal or external meniscus, one is reasonably sure of the diagnosis of a semilunar dislocation. This needs to be distinguished from osteochrondritis dessicans (the ordinary "joint mouse") and hypertrophied alar ligament fringes.

Radiographic studies will assist in this differentiation and here it may be remarked that it will be found of much assistance in employing the x-ray to determine the presence of a displaced semilunar cartilarge by the ordinary methods of exclusion of other things if oxygen is injected into the quadriceps pouch. This separates the synovial surfaces widely, leaving an absolutely black space wherever the joint surfaces could be separated, and if the cartilage is loosened from its moorings, the oxygen will work its way in behind it and show a black area there also. These appearances are identical with the black areas one sees in x-rays of the intestine where gas has accumulated. Bodies possessed of any opacity are thrown into high relief against this background. This method I first saw in use in the clinic of Major-General Sir Robert Jones of Liverpool, England. It has the merit of furnishing positive instead of merely negative evidence in a majority of cases of semilunar cartilage displacements. Once this diagnosis is made after careful study and examination, there is no treatment at all satisfactory except excision of the displaced meniscus. Every knee-joint should be gotten ready for operation by a two-day local preparation, and by the administration of 20-25 grs. of urotropine per day for two or three days before, and four or five days after operation. The technique of the operation is simplified if done with the leg flexed. The incision which affords the best exposure in a majority of instances is a slightly curved one with the curve toward the median line at its lower third. The upper two-thirds is parallel with the long axis of the femur and tibia and crosses the line of the joint after it has commenced to curve at a point over the juncture of the middle with the inner third of the internal meniscus. Nothing but instruments should be inserted within the joint and it is better to perform the operation under a tourniquet. On only two occasions have I seen a hemorrhagic

effusion in a knee-joint after this operation when done under a tourniquet. If the vessels are caught up before the capsular stitches are taken, any possible trouble would be avoided, and the advantages of the clean field, which are secured by the use of the tourniquet, would be gained.

The capsule should be closed separately from the skin and without drainage. The first dressing should be applied with firm compression from an elastic bandage. Fixation in a cast or ham splint is not necessary, and early manipulation is desirable. At the end of a week passive attempts to secure flexion should be made and by the end of the second week right-angled flexion should be possible. When this has been attained, walking may be permitted and by the end of the third or fourth week at the most, good function should be restored. Massage and resistive exercises should be directed to the thigh muscles (extensor and flexors) for a long period after the operation or until there is practically no atrophy remaining.

The diagnosis of hypertrophied alar ligaments is suggested when, after a trauma to the front of the knee-joint, or a severe strain unaccompanied by any history of locking at the time of the injury, the joint shows local swelling on either side the patella, and slightly below it. There is rarely any effusion in the articulation, but capsular thickening is quite common. The symptoms develop progressively two or three days after the injury and consist of pain or ache in the joint, particularly after standing or walking for a time. Complaint is made of a feeling of distention in the joint and stiffness which develops after keeping the leg in one position for a considerable time. When the trouble is marked there is often a sensation of pinching in the joint, but the carrying out of the motions is not prevented as it is in the semilunar dislocations. In the very chronic cases there may be some continuous inability to completely extend, but without pain or sense of locking.

If such persons are put to bed at the first of the trouble, within two or three weeks of the time that the trouble starts or a diagnosis made, a cast applied so that no further trauma may result to the hypertrophied ligaments, the proliferated tissue will be absorbed and the ligament be restored to its normal size. These injuries are purely traumatic. The initial trauma may be slight, but once the ligament becomes hypertrophied it is very easy through the every-day use of the joint, to add to the original injury little by little and create a situ-

ation which is hard to be recovered from, necessitating operative interference in some instances.

The alar ligaments serve as automatic distributors of the synovial fluid over the face of the femoral condyles. They are covered by synovial membrane and are made up of a mixture of fat and connective tissue, in such proportion and so arranged that a very plastic sort of a sweep is made useful for the purpose of keeping the synovial fluid properly distributed.

Trauma causes proliferation of both the fat and connective tissue elements and the entire ligament becomes converted into a gristly, hard substance that easily gets in the way of the flexion and extension of the leg. The synovial membrane becomes congested and injected, as does the synovia in the immediate neighborhood where the hypertrophied alar ligaments chafe against it.

If operative treatment is indicated,—and it is in the chronically irritated ones at any rate,—the best route to approach them is through a lateral incision on the inside of the joint, starting close up to the muscle near the top of the quadriceps pouch, and about half way between the edge of the patella and the adductor tubercle. With good retraction the hypertrophied ligaments are easily exposed and with scissors may be dissected out from the space between the front of the femoral condyles, the face of the tibia, and the inferior surface of the patella. Hemorrhage (venous) from this may be annoying, but can usually be controlled by washing out with hot water. The preliminary and post-operative treatment should be the same as in the semilunar lesions. After removal of the stitches the joint should be manipulated daily until full motion is restored. Because of denudation of synovia a tendency to the establishment of adhesions is rather more noticeable here than after semilunar operations, and therefore attention to the "follow up" treatment is imperative. Prognosis is good in these cases.

The third lesion referred to above, *viz.*, bicipital bursitis, is apparently a purely traumatic affair but the trauma is that of the inordinate use of the biceps femoris, combined with the fact that there is a minute communication between this bursa and the knee-joint. The typical bursitis is shown by swelling, the size of a twenty-five cent piece, over the outer aspect of the knee-joint beneath the tendon of the biceps and about one-half an inch above its insertion into the fibula. This is hard, tense, and full of a gelatinous material. The lining of the bursa is commonly somewhat thickened. Apparently when a trauma is in-

flicted upon the outer side of the joint the external semilunar may be dislocated, and as the normal communication between the bursa and the joint opens right at the insertion of the cartilage along the head of the tibia, I have on two occasions found a portion of the semilunar actually pushed out into the bursa through this opening.

The symptoms of this bursitis are pain over the region described above and tenderness to pressure. Sometimes the patients limp a good deal. In the Navy it has seemed to me significant that all the cases seen have been in seamen who have been obliged to climb up and down ladders a great deal, which is an exercise calling upon the biceps femoris for a good deal of work. It may well be that this, coupled with the fact that a communication with the knee-joint is of very frequent occurrence, would account for stirring up the bursa, and attracting fluid into it from the knee-joint.

The operative removal of this is the only method of treatment that gives permanent relief. The bursa should be dissected out and tied off from the knee-joint. Care should be used in the dissection because the external popliteal nerve is close to the head of the fibula and the biceps tendon; it has been injured in this operation with a troublesome peroneal paralysis.

The following cases are the ones referred to earlier in this paper and are cited chiefly to indicate the importance of an early diagnosis in troubles involving the knee-joint.:

Case 1. J. F-2. 22 years. March 29, 1919. While hoisting a timber with a jigger beneath a wharf the stick struck his lower leg from below and forcibly drove it up and out, knocking him off the girder upon which he was standing. Could not straighten the knee, but was able to go to "sick bay" of his own accord. Iodine was rubbed on it but nothing else was done. For ten months there was nothing else done for it, and then he was sent to the City Hospital on Blackwell's Island, but no recommendation for treatment was made, though at that time the leg was flexed and could not be extended. Shortly after this he was able to secure extension of it by his own efforts. After that he was sent back to duty and repeatedly since then there has been a re-dislocation of the cartilage which he has been able to manipulate back into place himself, but until he does there is no power to extend the leg completely. Sometimes it dislocates several times a day. Sometimes a long time may lapse between times. There is now no swelling connected with the dislocation, but pain invariably. The last time was a week ago. There have been a dozen or more x-rays taken which are said to be negative.

Physical Examination. Well developed and nourished man. Left knee appears normal, though the thigh and calf are slightly atrophied. In the sulcus between tibia and femur can be felt a resilient, slightly

movable mass where the internal meniscus of the semilunar lies. It is slightly tender over this place. There is no swelling of the soft parts or effusion in the joint. Flexion and extension of the leg are normal in extent and without spasm of muscle.

Diagnosis. Dislocated internal semilunar cartilage.

Case 2. S.P.G. U.S.M.C. 27 years. Christmas Day, December 25, 1916. In practicing high jumping he fell on the left knee, striking on the side, with the leg in a position of flexion. Had to be picked up and carried to quarters. Leg could not be completely extended for three months. There was much swelling and pain with tenderness over the inner aspect of the left knee.

He remained in bed with knee bandaged for four days, and was then returned to duty on December 30, 1916, with diagnosis of sprain. On January 6, 1917, reported again to "sick bay" because of synovitis and pain in knee. Then was transferred to hospital where the diagnosis of synovitis was continued. He was kept in bed ten days where he was given exercises and massage. On January 17, 1917, there was limitation in motion in flexion of the knee. On the 28th there was still some swelling and disability. On March 9, 1917, it is recorded that he was "exercising freely without marked discomfort." He was discharged to duty on this date.

From that time to November 18, 1918, no mention in his health record of any further trouble with the knee-joint, though the patient says that after March, 1917, when the hospital discharged him to duty with a diagnosis of sprain of the knee, that there had been about a dozen occasions when there had been a slip in the joint accompanied by pain, swelling, and limitation in motion. In the above mentioned interval he had had the diagnosis of mumps, urethritis, influenza, and chronic articular rheumatism.

On the third of March, 1919, he had a displacement of something in the left knee-joint, which was accompanied by effusion and pain. At that time he stated that from time to time this had occurred during the previous three or four months, with comparatively little provocation. He could do no bayonet drill without causing a slipping of the cartilage.

On the 12th of March I had opportunity to examine this man's knee. He stated that there had been recently three or four slips of the same sort that he had been having before. There was a moderate effusion; tenderness over the inner meniscus of the left semilunar and a palpable mass to be felt filling up the sulcus between the tibia and the femur. Forced extension and flexion are slightly painful. Calf and thigh show slight atrophy.

In view of the history and physical signs, it seems certain that this man's semilunar cartilage had been displaced on Christmas Day, 1916, but the diagnosis has been carried as "synovitis" or a "sprain," so far as the knee-joint lesion was concerned, ever since.

THE STANDARDIZATION OF JOINT RECORDS.

BY J. APPLETON NUTTER, M.D., MONTREAL, CANADA.

[From Clinic for Functional Re-education, New York.]

In a previous article (*Journal American Medical Association*, "Reconstructive Surgery—Problem of Records," February 8, 1919,) it was shown how finger deformities could be graphically recorded without sacrifice of accuracy or intelligibility, and with the gain of rapidity.

The writer has become strongly impressed with the necessity of adopting some standards by which joint movement and deformity may be recorded with a possibility of being understood. It is, of course, accepted that joint movements should continue to be recorded in terms of degrees, 90° standing for a right angle. Where this movement is to take its beginning is one problem that demands early solution.

For example, at the Clinic for Functional Re-Education it has been the custom, in measuring pronation and supination, to regard the position of "thumb up," the palm and dorsum of the wrist facing to one side and the other, as the neutral position. Pronation and supination are measured in terms of degrees from this neutral position

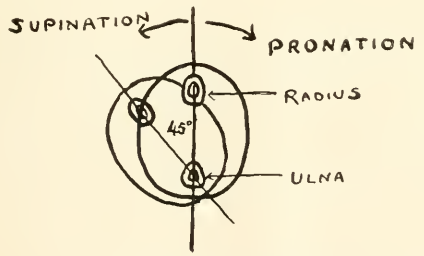


FIG. 1.—RIGHT WRIST, THUMB UP.

This diagram represents the right wrist cut across just above the carpus, showing the lower ends of radius and ulna. Diagram indicates the neutral or "thumb-up" position, also 45° of supination.

In the neutral position, the thumb being uppermost, the radius will be directly above the ulna. As the hand is pronated and supinated the radius will describe an arc of a circle around the ulna to one side or the other. One can accordingly record that only 25° of voluntary pronation is permitted beyond the neutral position, and for example, 90° of voluntary supination. This written description is of itself sufficiently

easy to understand if the neutral position is known and accepted. If, however, the written description is accompanied by a diagram such as follows, it would seem that the condition would be still more clearly portrayed.

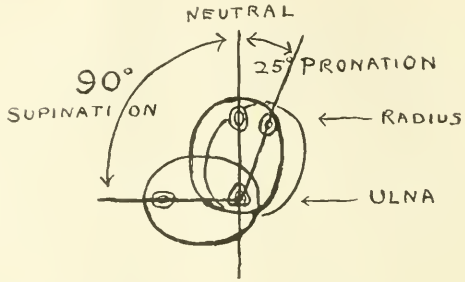


Fig. 2.—Right Wrist, Thumb Up.
This diagram illustrates range of motion in a right wrist amounting to 90° of supination from the neutral or "thumb-up" position, as well as 25° of pronation.

One problem that has created havoc among our aides has been to record a deformity where, for example, a forearm is held in marked pronation permitting of a few degrees only of motion towards the neutral position. Attempts to record such a condition in terms of degrees aided by descriptive language have not been usually successful as regards being understood. It goes without saying that the most elaborate description fails in its purpose if it is not easily understood by others than the writer. One has seen records that could be understood by many of the staff of a given hospital, but certainly could not be understood by a visitor to that hospital. In other cases it seems doubtful whether the records could be understood outside of the very room in which they were made.

In the Clinic for Functional Re-Education many attempts have been made to record pro- and supination in such a way as to combine accuracy with the greatest possible clearness. It was desired to have records that could be understood by an aide with only a minimum amount of anatomical knowledge. A condition as mentioned above—marked pronation with a few degrees of motion permitted towards the neutral position—would be recorded as in the following diagram.

The recording of the limits of forced movement in addition to voluntary movement has not been introduced in these diagrams for fear of

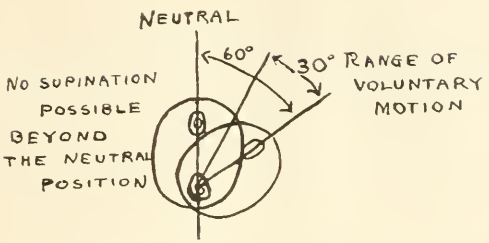


FIG. 3.—RIGHT WRIST, THUMB UP.

Arm shows active pronation to a point 60° beyond the neutral position of "thumb-up," with 30° voluntary motion from this point towards the neutral position. Or one could describe the same condition more briefly by saying that the arm shows voluntary motion in either direction between the points of 30° and 60° of pronation.

sacrificing clearness. It is, however, the custom of the Clinic to record passive (or forced) as well as active (or voluntary) movement. This is generally done in the same diagram.

In recording elbow movement it would seem that full extension, the upper arm and forearm being in one straight line, offers the best position from which to measure joint motion. The term "full extension" is usually employed in the description, as for example, "patient's arm lacks 20° of full extension." The writer is aware that in some clinics "full extension" is termed "180 degrees of flexion." This emphasizes the need of defining "flexion."

Flexion in the Clinic for Functional Re-Education is measured from this same position of full extension, and a man who can flex his elbow to a right angle is recorded as having 90° flexion. It is often the cus-

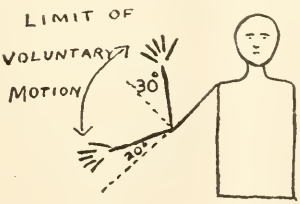


FIG. 4.—RIGHT ELBOW, SHOWING LIMITS OF VOLUNTARY FLEXION AND EXTENSION.

Full extension lacks 20°. Flexion to 30° beyond the right angle. In some clinics this would be termed "motion from a position of 60° flexion to one of 160° flexion." This diagram would probably be intelligible in any clinic where a written description might fail to be understood.

tom, especially when one of the staff has returned after examining the records of another hospital and found how easily it was to misinterpret, to make a graphic record such as follows. We will suppose a patient, who, after a dislocation of the head of the right radius, lacks 20° of full extension, but can flex to 120°, or 30° beyond the right angle.

A written description is somewhat more difficult to understand when the range of motion is limited, as for example, in the case of an elbow held habitually in a position lacking 30° of full extension, but capable of being flexed 20° from this point. A diagram of such a condition follows.

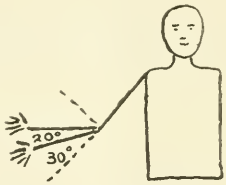


FIG. 5.—RIGHT ELBOW.

Diagram representing extremes of voluntary motion in the direction of flexion and extension. Full extension is lacking by 30°, and from this point 20° of voluntary flexion are permitted. Some would describe this as "motion between the positions of 130° flexion and 150° flexion of the elbow," where a fully extended elbow would be counted as 180° flexion. A diagram makes plain what is meant.

In the case of shoulder movements the difficulty seems to be largely one of agreement as to what constitutes flexion, abduction, etc. One finds a given movement described in many different ways. The most important movements of the shoulder seem to be abduction or raising the arm from the side away from the body, the so-called side elevation, and flexion, or raising the arm forward from the body, so-called forward elevation. Following this terminology logically, adduction of the

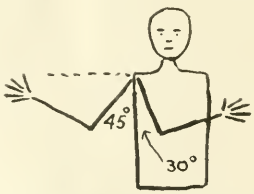


FIG. 6.—RIGHT SHOULDER.

This diagram represents the position of 45° abduction at the shoulder joint and that of 30° adduction at the shoulder.

shoulder would be putting the arm across the chest, and extension would be the movement which carries it backwards. Both flexion and abduction when carried to the full, raise the arm to the vertical position,

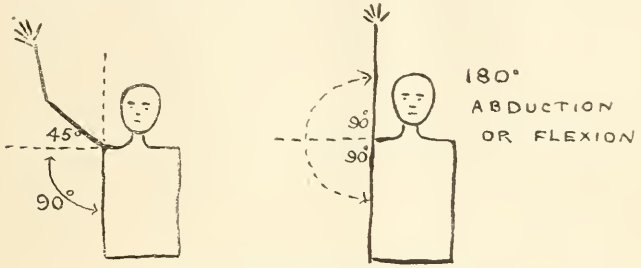


FIG. 7.—RIGHT SHOULDER.
These diagrams illustrate graphically the positions of 135° abduction at the shoulder and of vertical elevation at the shoulder joint, which may be 180° abduction or flexion.

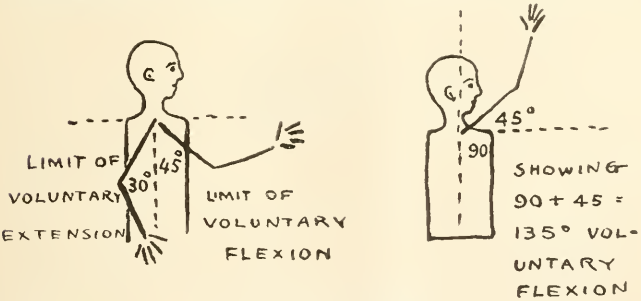


FIG. 8.—RIGHT SHOULDER.
These diagrams illustrate graphically 45° and 135° flexion of the shoulder joint and 30° extension of the shoulder.

In determining relations at the shoulder it must be remembered, or may be assumed, that the neutral position is one where the forearm, with the elbow flexed, points directly forward. A line through the condyles of the humerus at the same time, would run approximately from one side to the other. The condition of lessened external rotation at the shoulder joint is extremely important in cases where one suspects shortening of the tendon of the subscapularis or weakness of the external rotators. Graphic records for shoulder rotation will be considered in a later paper.

The question of records for movements of the lower limbs must be reserved for a subsequent article, but the writer cannot refrain from noting the confusion arising from the use of the terms "flexion" and "extension" at the ankle. The two terms are continually being misused and often one is in doubt about the accuracy of a given record for this reason. The terms "dorsiflexion" and "plantar flexion" are much preferable to "flexion" and "extension" from the standpoint of intelligibility. The custom at the Clinic for Functional Re-Education is to regard the neutral position of the foot as one where it is at right angles with the leg. Thus, for example, 30° dorsiflexion and 45° plantar flexion would be measured up and down from the position of right angulation. Here again a simple diagram aids in the avoidance of errors of interpretation.

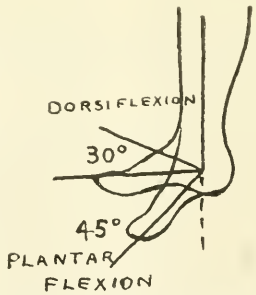


FIG. 9.—FOOT, SHOWING LIMIT OF DORSIFLEXION.
Foot showing limit of dorsiflexion (30° above the neutral position of right angulation) and of plantar flexion (45° below neutral position). This is not meant to indicate the limits of physiological motion in these directions.

The question of lateral movements of the foot is an involved one and must be left to a subsequent paper.

The writer, however, sums up his plea as follows:

1. Records of joint motion and deformity are as a rule unintelligible to the extreme.

2. They should be absolutely intelligible, as they are all-important in the treatment of the extremities.

3. Positions from which measurements are to be taken should be standardized.

4. Greater use should be made of graphic records, in the interest of intelligibility. Diagrams will make plain what we mean, even though we differ in our terms.

CASE RECORDING IN SPINAL CURVES.

BY EDWARD H. BRADFORD, M.D., BOSTON, MASS.

That there is a need of accurate records in observing cases of curvature of the spine is evident. No rational theory of treatment can be formulated unless based upon a foundation of positive facts and not upon conjecture, nor can a reliable prognosis be made unless based upon an experience with definite data.

It is for this reason that many methods have been employed to note the deformities of the trunk following curvature of the spine.

The most readily available method is by the photograph. But although there is no doubt that this method is useful, it is difficult to make it as accurate as is desirable. This is certainly true of round shoulder and antero-posterior deformities, in photographs of which the true character of the spinal and trunk outlines, lateral and pectoral, are masked by the projection of the shoulder blades, fat and muscle, but also in side curves with twists, in which contour defects may be masked by variations in lighting and shadow as well as in plate development and printing.

The skiagram is even less reliable, not only from the technical difficulties in accurate roentgenology, but because, owing to the difference in the ossification of growing bone and in the radiability of cartilage and of the thinner layers of young bone, the progress in curves at intervals of several months of growth cannot, by this method, be accurately estimated.

The elaborate devices for tracing contour: the hat measuring and pantogram appliances are unfitted for the ordinary use of practitioners.

Simplicity is an essential requisite provided it is not obtained with a sacrifice of accuracy. Anyone in charge of a large clinic and needing to rely upon assistants, will prefer to use simple methods if possible for his records.

The notes to be kept in antero-posterior curves differ from those needed in scoliosis, but in both it is essential to note the line of the spine, its flexibility or abnormal stiffness, as a measure of the skeletal deformity of the trunk.

It is of much use to note the variations in side flexibility of the spinal column in lateral curves. Abnormal limitation in any direction indicates abnormalities in bone structures, or in the shape of intervertebral discs, in the elasticity or length of intervertebral ligaments.

A simple method of recording this was suggested by Dr. E. G. Brackett. The lines of the spine are marked by a skin pencil. With the

FIG. I.—Tracing.—Side view.

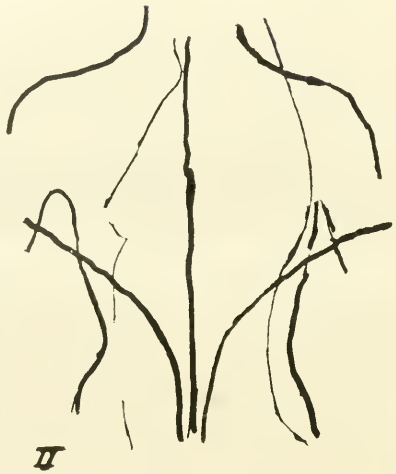


FIG. II.—Back view,—Normal lateral flexibility.

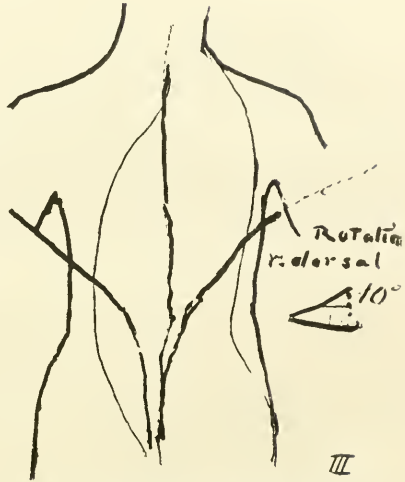


FIG. III.—Back view.—Limited lateral flexibility on the right side. Case of slight scoliosis in a rapidly growing child of fourteen. Right dorsal rotation ten degrees.

pelvis fixed, the patient is directed to bend to each side as far as possible, keeping the shoulders (*i.e.*, the upper part of the trunk) on the same plane as the cross axis of the pelvis; a straight line is then drawn on the skin, connecting the ends of the skin marks, with the patient bent first to one and then the other side, and the distances between the outer and the median lines noted with the patient in the erect posture. In this way, variations of the spinal lines in flexibility from the median position in extreme side motion to either side are noted. Some skill is required to draw the lines with accuracy.

The plan of covering the surface of the back along the spinal line with a strip of adhesive plaster closely and smoothly applied and marking the vertebral spines upon the cloth surface of the plaster has been made use of in records and can serve as a useful means of comparison except in the more pronounced distorted backs.

Attaching to the vertebral prominences by means of a strip of adhesive plaster a string with a weight at the end, making a plumb line, and noting the variation of the spinal line from this plumb line, furnishes a simple method which can be made of service.

Viewing the back through a frame holding a sheet of transparent celluloid and marking on the surface of the celluloid the spinal lines, gives a method of convenient record where the back can be placed in close contact with the celluloid plate, and the marks can easily be transferred to the paper to be filed with the other notes of the case.

These methods, though simple and sufficiently accurate for ready use, are insufficient to record the desired facts of the curves in round shoulders or the amount of rotation in scoliosis. A satisfactory, simple, and inexpensive method for recording rotation in scoliosis is not easily found.

A small pendulum arrangement has been suggested and used. It is easily made:—a flat bar slightly curved upward at the middle so as to permit the bar to be placed upon the recumbent back is armed with an upright projecting from its middle, to which a short pendulum is attached. The variations of the pendulum as it swings according to the slope of the cross plane of the back of the recumbent trunk can be noted if a scaled plate is secured behind the swing of the pendulum. An attached spirit level marks normal symmetry in contour of any cross section of the back as the patient lies flat on an unyielding surface.

This simple mechanism is faulty chiefly on account of its delicacy, the pendulum oscillating with the breathing of the patient. Some care

is necessary to eliminate these variations and determine the exact point of inclination to be noted.

A less delicate record and one, therefore, more adapted to ordinary use, can be made by a simple form of a quadrant. A scale marked device, somewhat resembling a quadrant but differing, however, in that the moving arm moves up and down instead of as a pendulum.

If the side of the quadrant is placed transversely across the back, the index arm raised to a level indicates on the scale the degree of the rib rotation at that portion of the trunk. As the scale is large, the markings are easily read. The level of the recording arm can be adjusted by the use of a small pendulum hanging from the index arm.

This device has an advantage, through its coarser adjustment, of more ready use over the spirit level arrangement just mentioned. The method often recommended of tracing the lines of the back placed close to a glass plate with the pelvis secured, has many advantages if employed in a simple form. It requires, however, a diopter to secure accuracy. If the eye looks obliquely or at different angles at the sides of the trunk or the slope of the shoulder or hips, the tracings will vary and lose accuracy. A simple and easily-made diopter is furnished by piercing a small cube of metal or wood, easily moved by the hand and kept flat on the plate glass surface, and inserting a small brass tube, large enough and not too large to be looked through on, to the point of a pencil placed obliquely in the block and adjusted to mark on the glass.

Glass marking pencils, obtainable at stationers, make a sufficiently clear mark. A darker and more readily made mark is made by the eye-brow pencil of the actor. These, however, are so soft that they are soon worn and quickly need replenishing. Still darker marking can be made by using instead of the pencil a small water-color brush dipped in black paint.

The patient should be seated or stand with the back as near as possible to a plate of transparent glass, in a well-lighted room with a white screen or light contrasting surface in front. The pelvis is sufficiently secured if the patient straddles a chair or sits squarely on a stool, or if standing, with the feet somewhat apart and the anterior superior spines held firmly against the back of a properly placed chair back, on which the hands can also be placed with the arms spread from the sides of the trunk.

The patient places herself in a less unnatural and rigid position in this way than if more firmly secured, and this furnishes a more satisfactory position for a record, and the recorder can easily notice and

correct any undesirable sitting or standing attitude and observe if the plane of the shoulders and pelvis is not parallel with that of the glass plate.

The lines of the shoulders, trunk and hips can be readily and accurately traced and marked on the glass by means of the pencil-armed diopter,—and also the tips of the scapulae and the marked lines of the spines of the vertebrae with the patient standing straight or bent to either side, care being taken that the side motions are made without twisting the plane of the shoulders and pelvis away from the plane of the glass.

Tracings on tissue paper taken from the lines marked upon the glass serve as permanent records and can be folded and kept compactly with other notes of the case.

It is evident that the glass plate must be firmly fixed on a suitable stand. This is easily arranged by placing a piece of window glass of desired size in an unbacked picture or mirror frame and securing this on a suitable stand.

If a number of cases are recorded by the above mentioned methods and the tracings examined, facts of interest will be noted, especially in regard to the variations in the side flexibility of the line of the vertebral spinous processes, both in normal cases and in those with pathological curves. In many instances without curves the side flexibility to the right will be found greater than to the left and the centers of greatest side flexibility will vary considerably as to their localization in the vertebral column. This, in some instances, is probably due to osseous or cartilaginous anatomical idiosyncrasies and in others the results of ligament adaptations to acquired habits of attitude or movement. These lines of curves furnish useful records, both of an abnormal condition of spinal mobility or of changes under treatment or observation, and may serve as a useful diagnostic symptom of early structural change not yet apparent to the eye.

The tracings of the side view of the spinal column and thorax are also of much value to enable the surgeon to note the changes, during growth or under treatment, of the osseous structure independent of attitudinal changes in the position of the scapulae.

These are readily made by means of a tracing rod bent at the end so as to pass along the line of the spine of a patient standing sideways; the other end of the tracing rod is furnished with a pencil bearing plate at right angles to it moved along a flat surface. This enables a marking to be made on paper placed upon the flat surface (*i.e.*, a wall

or flat door). This marking traces the line of the back as the rod moves down the spinal line and does not record the projecting shoulder blades. A tracing of the sternum and front line can also be made in the same way, thus giving a side cross section tracing of the trunk.

MESIAL TRI-PRISM.

BY WILLIAM JACKSON MERRILL, A.B., M.D., CAPTAIN, M.C., U.S.A., PHILADELPHIA, PA.

It will be seen by the accompanying cuts that the principle of this support placed between the soles of the shoe consists of three prisms, one running forward, the second running backward, from the mid-transverse line 3 (Fig. 4). The third prism, formed by the first and second, extends from the mesial side outward (Fig. 3). The outer edge of the tri-prism should be inward to the mesial side of the fifth metatarsal bone and not under it. The thin edge may extend slightly under the fifth metatarsal bone but not under its head. Placed in this manner the triprism does not raise up the distal head of the fifth metatarsal bone. Any device that extends completely across the sole of the shoe just back of the heads of the metatarsal bones and is held insecurely by the flexible sole, will, in the first place, cock up the distal end of the fifth metatarsal bone and strain the metatarso-phalangeal joint, and in the second place tend to abduct the forefoot. Such a device, especially when it is not stabilized with the heel of the shoe, will add mechanical factors which increase foot strain and disability.

In weight bearing the supporting points of the foot are, the tuberosity of the os calcis, the tuberosity of the fifth metatarsal bone and the distal heads of the five metatarsal bones. Normally in weight bearing the fifth metatarsal bone should be in normal alignment with the cuboid, os calcis, and its phalanges and parallel with the ground or its supporting structure, the shoe. If the average height heel be used and some device be placed under the distal head of the fifth metatarsal bone to raise it disproportionately with its proximal end, strain will

be applied to the metatarso-phalangeal joint, which is not only acutely painful but may produce a traumatic arthritis of that joint; consequently it is rational to so construct the sole of the shoe that the line from the heel to the toe shall agree with the normal alignment of the outer structures of the foot.

By using under the heads of the first four metatarsal bones, a wedge stabilized with the heel of the shoe, flattening of the feet, pronation of the feet, valgus of the foot and torsion of the tarsus may be corrected without applying straining forces to the outer structures of the foot.

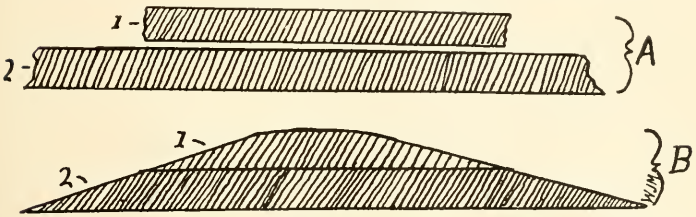


FIG. 1.—Strips of sole leather (A) 1—,2″ to 2½″ and 2—,3″ to 4″ in width are cemented together. These strips may be of any length. After being cemented together they may be skived—as (*B*) cross section—and from this strip triprisms of the desired size may be cut. The strip 1-*A* may be rubber to prevent squeaking.

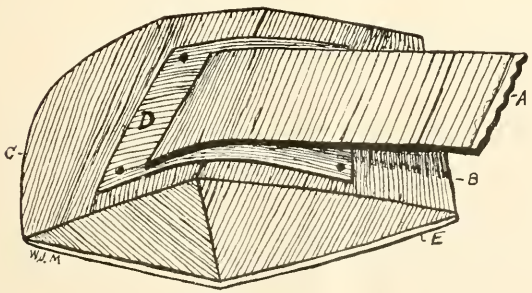


FIG. 2.—*A*, shank— anterior end bent to form curve upward: *B*, posterior edge of posterior prism: *C*, anterior edge of anterior prism; *D*, thin steel plate to prevent shank from cutting through leather; *E*, rubber to prevent squeaking.

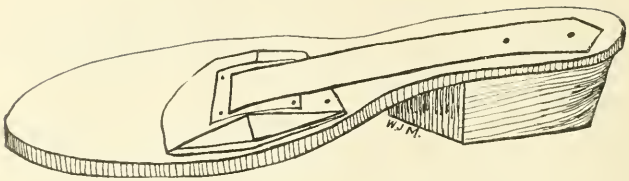


FIG. 3.—Shows the placing of triprism and the steel shank.

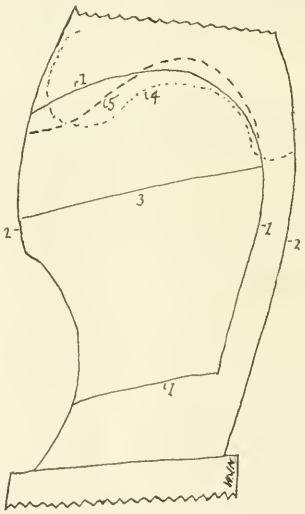


FIG. 4.—Outline drawing of triprism, showing its limit laterally and the possible variations of the anterior edge: 1 (————), the usual form; 5 (- - - - -) to extend under the 2nd, 3rd, and 4th metatarsal heads, and 4 (. . . . .) to form a depression for the ball of the great toe. The prism may extend backward to any desired point. The anterior limit of the prism is determined by putting the shoe on the foot, finding the joint lines of the 1st and 5th metatarso-phalangeal joint, marking three points on the sole of the shoe. Draw a line between these points and curve the anterior edge of the triprism as indicated. The anterior thickness should be made to suit the given case.

The author has used this device in the treatment of a number of cases in which the conditions just named have existed, and when the appliance has been properly adjusted relief has been obtained. It has been especially satisfactory in the treatment of cases of torsion of the tarsus in which the distressing symptom, metatarsalgia, existed.

It has also, as an adjunct to physio-therapy, given good results in the treatment of flaccid flat feet. The author had acute foot strain as a result of torsion of the tarsus, producing intense metatarsalgia and tarsalgia, which was relieved by this device.

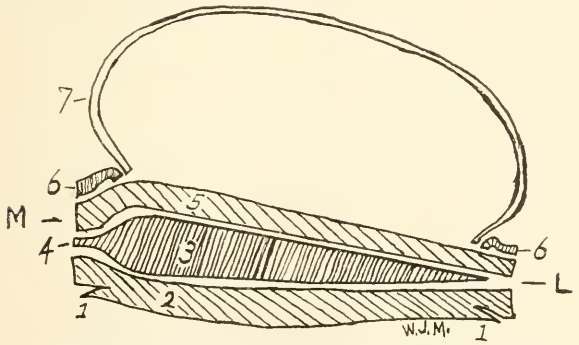


FIG. 5.—To indicate cross section in triprism at 3 (Fig. 4). 7, upper; 6 welt; 5, inner sole; 4, mesial edge skived down to be stitched between soles; 3, cross section of tri-prism at thickest point; 2, top sole; 1, channel for stitching; *M*, mesial, and *L*, lateral sides.

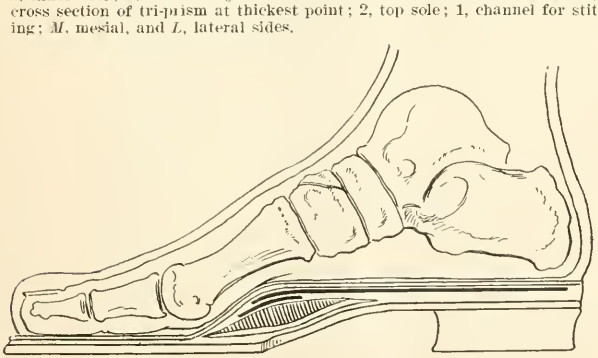


FIG. 6.—To indicate where the pressure should be made under the ball of the foot.

Every orthopædic surgeon who has had considerable experience in the treatment of foot disorders understands that any device, whether it be a shoe or some appliance combined with a shoe, plays a very small rôle in the treatment and is only temporary. He should at least understand the importance of constitutional measures as well as local, the latter consisting of massage, exercises, correct posture, indicated applications, etc.

As a rule a loose support in the shoe, such as arches, plates, pads, etc., does not accomplish the object of its use, chiefly because it is an unstable, shifting device and does not form a secure foundation for the foot. All supports, arches, etc., worn in the shoe abduct the forefoot. When a support is needed it is much more efficient when so fixed to the shoe that it will not shift or roll under the foot in weight bearing.

The practice of placing a mesial wedge under the first metatarsophalangeal joint is an infraction of fundamental mechanical principles. In certain cases of arthritis, excessive pronation, extreme weakness and flaccidity, a long mesial wedge from tip of heel to toe, being thicker under the heel than under the ball of the foot, is a rational measure.

Whatever type of support is used to supinate the tarsal structures, it should have a stiff shank to stabilize it with the heel, because in the first place the anterior device will roll and twist independently of the heel and apply torsion stress to the foot, and in the second place, especially with a weak foot, the mid-tarsus will buckle, raising the distal heads of the metatarsal bones disproportionately.

By a stiff shank is meant a shank constructed of steel of moderate temper, of No. 16 to No. 19 gauge, depending upon the weight of the person and the temper of the steel, and broad enough to sustain the weight applied to it without bending and altering in shape. When spring steel is used the temper should be such that the shank will return to its designed shape after the weight of the body has been applied to it. In any case the temper of the shank should be such that it will be possible to change its shape at will. Number sixteen sheet spring steel will serve the purpose. This feature is of great importance because it will be found in certain cases that it is necessary to raise the distal end of the pad and in other cases the mid portion, disproportionately. This can be done to suit the needs of the case by using a hollow block and a round-faced rawhide mallet. The moulding feature will be found valuable because in most individual cases the shape of the support must be changed from time to time.

A SIMPLE SPLINT FOR THE TREATMENT OF FRACTURES OF THE CLAVICLE.

BY RUSSELL L. HODGE, CAPTAIN, M.C., BASE HOSPITAL 28, A.P.O. 753.

When the clavicle is fractured a characteristic deformity presents. The shoulder drops downwards, inwards, and forwards. The deformity is easily reduced, but to keep it reduced, without too great inconvenience to the patient, is extremely difficult. If the patient could be kept lying on his back on a hard mattress with a long, narrow, firm pillow along his dorsal spine between the scapulae, gravity acting through the shoulders would reduce the fracture and maintain the reductions. No normal human being would submit to this treatment, but the principles of the treatment can be fulfilled by using a T shaped splint in place of the mattress and pillow, and by substituting properly placed straps for gravity.

The Splint. Take two pieces of wood $2\frac{3}{4}$ inches wide and $\frac{1}{4}$ inch thick and nail them together so as to make a T (Fig. 1). The longi-

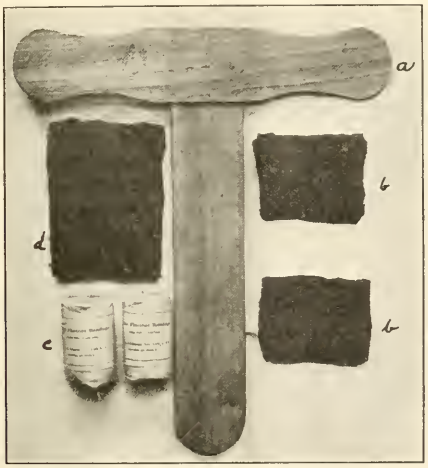


Fig. 1.—*a*, The splint; *b*, axillary pads; *c*, bandages; *d*, dorsal pad.

FIG. 2.—Splint being applied. Dorsal pad being inserted.

FIG. 3.—Splint applied. Back view.

tudinal part or stem of the T is 23 inches long. The transverse part or cross of the T is 20 inches long and its upper edge is hollowed out to a depth of about one-half inch for three inches near its two extremities. This hollowing permits the easy and secure application of a bandage.

Application. Pad the splint thoroughly. Place the splint on the back of the patient in such a manner that the cross piece rests as high as possible along and above the superior borders of the scapulae, while the stem extends almost vertically from the body.

Place a felt pad 4x6 inches in size over each axilla so as to protect the axillary vessels and nerves. Fix the cross piece of the splint snugly to the shoulders by means of a figure of eight bandage of canton flannel four inches wide. The hollowing of the cross piece prevents the bandage from slipping; the felt pads protect the axillae from pressure.

Push a piece of felt, 6x8 inches in size, between the splint and the cervical spine. Note that the stem of the cross projects backwards from the body like a lever (Fig. 2). Push the stem of the cross down against the dorsal spine and fix it in position by a bandage surrounding the body (Fig. 3). The stem of the splint thus acts as a lever pulling the shoulders backwards and upwards (the cross piece having been placed high up). Outward traction on the shoulder is obtained

FIG. 4.—Splint applied. Front view.

by the figure of eight bandage covering the felt pads in the axilla (Fig. 4).

1 The splint is suitable for both bilateral and unilateral fractures.

2 The application of the splint reduces the fracture painlessly.

3 The arms are left free and thus muscular atrophy is avoided.

4 The patient can use the arm on the injured side for any ordinary purposes, such as writing, feeding himself, etc.

5 Accurate apposition of the fragments of the bone is obtained.

6 Open wounds are easily accessible for treatment without disturbing the apparatus.

Orthopaedic Society Meeting.

BRITISH ORTHOPAEDIC ASSOCIATION.

SPECIAL MEETING, MAY 30 AND 31, 1919, LIVERPOOL.

PROGRAMME.

Friday, May 30th.

At the Liverpool Medical Institution, Mount Pleasant, Liverpool.

10 A.M. Executive proceedings.

10.30 A.M. Discussion on "The Treatment of Flail Joints of the Upper Limb, Following Gunshot Injuries." Opened by MR. NAUGHTON DUNN and MR. HARRY PLATT.

12 A.M. "The Anatomy of Snapping Hip." Professor F. WOOD JONES (by invitation).

Demonstration of radiograms of a case of tuberculosis of one hip joint associated with congenital dislocation of the opposite hip. MR. A. ROCYN JONES.

1 P.M. Luncheon.

2.15 P.M. Two Cases of Unusual Accidents to Amputation Stumps. MR. E. MUIRHEAD LITTLE.

Some Speculations on the Functions of Scar Tissue. MR. D. MCCRAE AITKEN.

Observations on the Treatment of Static Disabilities of the Feet. MR. W. H. TRETHOWAN.

On the Operative Treatment of Paralytic Talipes Calcaneo-cavo-valgus. MR. NAUGHTON DUNN.

7.30 P.M. Dinner. Adelphi Hotel.

Saturday, May 31st.

At Alder Hey Special Military Surgical Hospital.

10 A.M. Demonstration of Patients and Operations. MR. T. R. W. ARMOUR, MR. T. P. MCMURRAY, and other members of the hospital staff.

2 P.M. Visit to the Children's Country Hospital, Leasowe, with MR. T. R. W. ARMOUR.

Visit to the Liverpool Country Hospital for Children, Heswall-on-Dee, with MR. T. P. MCMURRAY.

Book Reviews

Functional Prosthesis of the War Wounded. Ducroquet. Paris, Masson et Cie, 1919.

In this little book the mechanics of supporting braces is presented in great detail. Extreme care has been given to the proper axis for the joints, which is made in each location to conform to that of the normal limb. The centering of the axis has been made the subject of experiments on the cadaver and on the living. The center for the metatarsophalangeal joint is found to pass through the heads of the first and fifth metatarsals. The center for the ankle corresponds approximately to the axis of the cylindrical portion of the astragalus, passing just beneath the inner malleolus, and is therefore oblique backward and outward. The axis of the knee centers through the femoral condyles at the level of the upper insertions of the lateral and the crucial ligaments, three quarters posterior. The axis flexion of the hip passes through the femoral axis of the knee centers through the femoral condyles at the level of the upper insertions of the lateral and the crucial ligaments, three quarters posterior. The axis of flexion of the hip passes through the femoral heads at which level the joint of the apparatus should be placed. Here we have also two other types of motion to consider: abduction-adduction and rotation. The abduction is provided for by a second joint in the apparatus immediately below the flexion joint and in plane at right angles to it. The elbow has only one motion, for all practical purposes, the axis of which corresponds to the center of the epitrochlea. Of the three motions of the shoulder (flexion, abduction and rotation), the last is disregarded and the apparatus is fitted with two joints, one above the other and at right angles to each other, to provide for the flexion and abduction.

A chapter is devoted to splints for immobilization and braces with joints to support members in motion. Emphasis is laid on the points of support. For example, in case of a splint for holding the knee in extension the two points of support are the gluteal mass and the heel, and the point of counter pressure is the front of the patella. Any splint not extending to these two points of support falls short of its purpose.

Another chapter deals in a comprehensive manner with modifications of shoes for correction of foot deformities or for improvement, either cosmetic or functional, of a foot with an incorrectible deformity. A cinematic study of normal gait compared with that of patients with shortening of one leg, ankylosis of the ankle or knee and other deformities of the lower limbs, furnishes three interesting chapters.

Pseudarthrosis of the bones of the lower limbs is sometimes curable by proper supporting apparatus. Its occurrence is most frequent in

the lower leg, is rarely seen in the neck of the femur and practically never in the femoral shaft. For a pseudarthrosis of the middle or lower third of the tibia a molded leather or celluloid reinforced brace, lacing in front extending to the knee is recommended. This brace includes the foot and has an ankle joint if the fracture is in the middle third. If in the lower third no ankle joint is provided. A similar apparatus serves for an upper third pseudarthrosis, but here it is extended up on the thigh and is provided with a knee joint as well as an ankle joint. The author states that he has had consolidation in delayed unions of more than a year's standing with such an apparatus Pseudarthrosis of the radius is more frequent than that of the ulna. In the elbow it may be of the flail type or of a less movable type. The former is much more common. The condition may be ameliorated by a brace extending from a shoulder cap to the wrist with a joint at the elbow which allows flexion and extension only. Complicating a pseudarthrosis of the humerus one may encounter an ankylosis of the elbow or of the shoulder, destruction of the flexor muscles of the elbow or a paralysis of the radial nerve. Several varieties of braces for false joint in the humerus are described. The simplest is a molded leather one with shoulder cap, with lacing and without joints. This holds the two fragments in line. Some of the more complicated forms have joints either at the shoulder or the elbow or both, depending upon the location of the lesion or the muscle complications.

One is inclined to wonder, however, why any sort of supporting apparatus should be used for these pseudarthroses when it would be possible in most cases to do away entirely with the lesion by an operation for inserting a bone graft.

Methods of examining various muscles of the upper and lower limbs by palpation to determine whether or not they are active, are described in detail. This chapter is followed by one on paralyses due to lesion of various nerves and the apparatus for support and relief of tension on the affected muscles.

Contractures of muscles and tendons of the lower limbs producing, for example, pes equinus and pes varus are best treated by operations, especially after they have existed for over a year. Medio-tarsal and subastragaloid arthrodesis is recommended for equino-varus of long standing—*William Arthur Clark.*

A Treatise on Orthopedic Surgery. By Royal Whitman, M.D. Sixth Edition. Lea and Febiger, Philadelphia and New York. 1919.

The appearance of this excellent book in its sixth edition proves anew its value as well as the growing interest in orthopedic surgery. The author's aim has been, as he says in the preface, to emphasize the constant purpose of orthopedic surgery to prevent or to correct deformity and to preserve or to restore function, a purpose that governs

treatment from the beginning to the end. In striving toward this aim the author still clings to the old conception of orthopedic surgery, yet throughout the whole book one notices a refreshing breeze of progressive modern spirit. The objection may be raised that the book does not entirely and sufficiently cover all the subjects which come under the care of a present day orthopedic clinic, especially as concerns adult cases. However, as the borderlines of orthopedics are so manifold and so different in different clinics, certain restrictions have to be made, and on the whole we feel that the author has displayed great wisdom in the making of these restrictions, though we would like to have the scope of certain subjects, such as faulty posture, somewhat extended.

The great advantages of the former editions, clear, logical diction, scientific spirit, and sound conservative judgment are also noted in the new edition as well as in the chapter on Military Orthopedic Surgery which is added to the book. In this chapter the rules of the selective service governing orthopedic disabilities are given in detail. Then follows a description of other appliances of approved value as well as certain operative methods in war fractures. Artificial limbs and kineto-plastic amputations are considered next. The surgical treatment of peripheral nerve injuries is dealt with in some detail, covering most of the important nerves and describing methods of transplantation for hopeless injuries of the median nerve and others. The student is informed about the proper attitude of election in case a joint is expected to become stiff. Early exercise and massage in infected joint wounds is mentioned with a certain conservative restriction and the chapter is concluded with short remarks on reconstructive treatment.

The contents of this chapter show how much the field of orthopedic surgery has been enlarged by the experiences of the war. It will take time before these experiences can be sufficiently amalgamated with the original scope of orthopedics, but this, in my opinion, will come, and we are satisfied with the hopeful beginning expressed in this valuable addition of Whitman's book.

Current Orthopaedic Literature

Numerals at head of each abstract are for use in connection with the official "Classification of Orthopaedic Literature," published in the JOURNAL for January, 1917, reprints of which are obtainable from the JOURNAL office.

III. ORTHOPAEDIC OPERATIVE, POST OPERATIVE AND ADJUVANT TECHNIC.

III, 1.

THE CLOSURE OF CAVITIES IN BONE. Lieut-Col. Perry Sargent, D.S.O. *Journal of the Royal Army Medical Corps.* February, 1919.

The periodic curetting of a sinus leading into bone is a practice which merely illustrates the triumph of hope over experience.

The processes of repair in bone differ in no fundamental respect from those which occur in other vascular tissues, but they are modified by its peculiar and complex structure. Bones vary in their vascularity according to their density and so we find cancellous bone more adapted for recovery than compact bone, and young bones than old. The denser the bone the more readily does necrosis occur; the less easily do sequestra separate, and the more slowly is healing effected.

In order that a cavity may become obliterated, and firmly and finally healed, its walls must be approximated until the granulations which cover them are able to coalesce.

No tourniquet is employed. The use of a tourniquet certainly renders certain stages of the operation more easy, but the subsequent oozing is a great drawback. Haemorrhage is easily kept under control by the frequent application of large pieces of gauze wrung out in very hot saline. As a rule, the operative field can be kept dry by this means. Further, it is easier to judge of the condition of a bone which bleeds under the curette than one which is temporarily deprived of its blood supply. Again, as these operations consume a considerable amount of time, the total deprivation of blood for an hour or more of skin whose nutrition is already impaired by scarring, may result in subsequent sloughing.

One of the most essential points in the operation is to secure a sufficiently thorough exposure of bone both above and below the site of the cavity which is to be attacked. The surgeon must see exactly what he is doing in every part of the operative field, and not trust to the curette for discovering hidden recesses.

The author usually begins by a fairly wide excision of the wall of the sinus, which leads down to the bony cavity. When more than one sinus exists, he selects the one which is most conveniently situated, and which gives the easiest and most direct access to the bone, having regard to the anatomy of the structures in the neighborhood. Any other sinuses may or may not be dealt with according to their situation and the density of their walls.

The periosteum is next incised, to the extent of the whole length of the wound, and stripped from the bone so as to bare it completely—not only at the actual site of the cavity, but for some distance both above and below.

At this stage it is convenient to employ Lane's bone levers instead of the ordinary retractor, so as to bring the bone into prominence by depressing the soft parts. They are inserted between the periosteum and the bone.

Before attacking the bone, it is necessary to pack it off by means of gauze pads, partly to prevent soiling of the wound generally, but particularly to prevent fragments of bone getting lost among the soft parts and being accidentally left behind. This is most important, more than one of the failures being due to the leaving behind of bone chips.

That part of the operation which consists in preparing the cavity for the graft is entirely sub-periosteal.

The bone so exposed can be thoroughly examined and a decision made as to which wall of the cavity can best be spared from the point of view of strength of bone. Other things being equal, that aspect of the bone is selected for removal which is most conveniently related to such overlying muscles as can best be employed by filling the cavity.

These points being decided, the cavity in the bone is fully opened up by means of a chisel and mallet, until every part of it can be thoroughly explored. All granulation tissue and dead or carious bone must be removed and all recesses followed up and cleansed. The cavity is next washed out with hot saline solution, and plugged tightly with gauze. This completes the first stage of the operation.

The second stage is not commenced until all soiled packing has been removed, the towels changed, the instruments re-sterilized and the surgeon's and assistant's gloves have been changed. From this point onwards, the operation must be regarded as an aseptic procedure. The wound, of course, is not free from bacteria, but their number has been so reduced that the tissues can deal with the remainder.

The actual method of filling the cavity with muscle is different in every case: what one must do is to fashion from the most conveniently situated mass of muscle a thick broad-pedicled flap of approximately the same size as the cavity. It is a plastic operation based on the same principles as those which govern plastic operations in general and the main point to be kept in mind is to secure an adequate blood supply to the transplanted muscle. The muscle graft is now pushed into the cavity and pressed home firmly; it readily adheres to the bone. A few stitches of catgut may be required to bring together the overlying muscles and to assist in keeping the graft in position. The skin is loosely sutured and the subsequent escape of exudate is provided for by means of rolls of rubber sheeting inserted in convenient parts of the wound. It is important to place one such drain in the space from which the muscle graft has been cut, as was pointed out by Captain Z. Mennel, who has had a large experience with the operation. These drains are usually removed at the end of forty-eight hours. The limb is splinted in such a way as to relax the parent muscle. *Leo C. Donnelly, Detroit.*

III, 3 and 7.

Segmentary Bone Grafts in Military Surgery. Dr. Mauclaire. *Bull. de l' Académie de Médicine*, January 28, 1919.

Before proceeding to operate one should note carefully how much loss of substance is present and how much time has elapsed since the original injury.

No operation should be undertaken for some months after the wound has healed, and if sepsis was present, six months at least should elapse before bone grafting is done.

The author's favorite method is to make a pointed graft (no matter from what bone it is taken) and to introduce it in the medullary canal above and below. He lays particular stress on the necessity of not handling the graft even with the gloved hand.

A report of 128 cases with 72 successes he estimates too high a percentage; he feels that some of the non-successes were not reported; his own percentage was 7 cases out of 23; among the 23 cases there were some in whom the skin was very thin and invaded by a great deal of fibrous tissue.

He prefers the osteo-periosteal graft of Ollier, which was proven to be the most successful during the Russo-Japanese war and by M. Delagenière during the recent war.

He observed for two years an osteo-periosteal graft of the tibia where at the end of that time the graft was hypertrophied and union firm.

In another case observed for the same length of time a bone graft without the periosteum was found atrophied.

It is evident, then, that he prefers the graft with its covering of periosteum.—*Daniel LeFerté, Detroit.*

III, 7.

Osteoplastic Surgery During the War. Charbonnel. *Journal de Médicine de Bordeaux.* January 15, 1919, p. 8.

Constructive surgery of bone has grown more important during the war and there is no doubt that more surgeons practice it now than formerly. The impetus for this has been, first, the enormous number of fractures, and second, paradoxical as it may seem, that most of the fractures have been open ones. Up to the end of 1915 most surgeons hesitated to apply fixation of any kind to open wound fractures, but little by little the practice of wiring and plating became common, until at present, it is fairly well established that open fractures may, within the first twenty-four hours, be fixed by plate or wire until they are bacteriologically clean, when the wound may be closed. The technique of such operations should be none the less perfect on account of the existing infection, for it is not permissible to add one infection to another. Such an operation will preclude the displacement of fragments by muscular contraction. The means of coaptation should be very powerful and if screws are used they should be set as far as possible away from the seat of the fracture. One must not be in a hurry to remove the means of fixation in case of supervening suppuration. Conserve the soft parts, use Dakin's solution if need be, and when clean remove the plate or wire on doing the secondary suture of the wound.

Fourteen cases of primitive fixation by wire or plates are reported. Some of these had primary union, some secondary after sterilization with Dakin's solution.

For later cases, in which there has been complete esquillectomy and the infection has entirely gone, a bone graft should be done to fill in the defects where necessary. It is advisable to do a bone graft for forearm and leg where there are two bones, and to use metallic support for defects in single bones such as the humerus.

Pseudarthrosis and delayed union furnish a special field for osteosynthetic operations. The Lambotte plate is recommended by Villard and it is stated that it serves not only to immobilize the fragments but to furnish an irrita-

tion which acts as a stimulus to calcification. The author, however, is not entirely in accord with this method and can not reconcile it with the rarefication usually observed under metal plates screwed to the bone. Those cases consolidating after plating would probably do so without the plates, as many do after only irritation with or without curettage.

With the loss of substance of five centimeters or more, a total segment graft is advised. Some authors advocate fastening such a graft at each end with wire, but such a procedure defeats the purpose.—*William Arthur Clark, Chicago.*

III, 11.

Some Errors and Prejudices Concerning Mechanotherapy. Sandoz. *Paris Médical,* February 1, 1919, p. 103.

Introduced into France about thirty years ago, mechanotherapy has only slowly gained the recognition of the medical profession. In the beginning of the war it aroused more interest to the extent that many came forward with systems new and untried with the result that the method as a whole suffered some discredit on account of poor and indifferent results obtained by inexperienced workers.

A mistaken idea held by many of the medical profession is that mechanotherapy consists in breaking up ankylosis by machines or whatever force is required. On the contrary, the method is, first of all, one of gentleness and patience, repudiating all maneuvers of force. Another error arising usually among masseurs, is that it replaces massage with a gross and brutal system. The answer to this is that it never has pretended to replace manual treatment entirely, although there are many cases in which mechanotherapy offers a distinct advantage in economy of time and in obviating fatigue.

The most insistent adversaries of the method are without doubt those who manifest an unlimited enthusiasm for manual exercises as a means of re-education. These views have had a wide influence on the public who are more or less ignorant of the real and comparative values of the different methods. Manual exercise, however, is only a complement to the methods of mechanotherapy.

To the question: what is mechanotherapy? the author replies by quoting Lagrange: "Mechanotherapy is only the employment of the mechanical means invented by Zander, for applying the system of medical gymnastics founded by Ling." This method of Ling, usually called the Swedish method, comprises both passive and active movements. Zander conceived the idea that many of these movements performed by hand might be done by machines. It might be said that mechanotherapy is a perfection of the methods of Ling, because a third factor, a combination of active and passive movements, is introduced and a very accurate means of graduating the exercise is provided by levers with adjustable weights.

A complete equipment consists of about sixty machines, of which about twenty are for passive exercises, a half dozen for activo-passive exercises and the rest active or corrective. The minimum is about forty. With less than that number one can not carry on unless liberally aided by hand work. The author makes a decided distinction between mechanotherapy and the methods of the so-called arthromotors which are wrong both physiologically and therapeutically.

Regarding the objections of the manual gymnasts the author admits that the human hand is better than a machine, but affirms that good results are obtained in shorter time and in greater numbers by mechanical methods.

It is also noted that the most competent of the manual gymnasts admit the possibility of good results by mechanical means.

Functional re-education by manual work should be undertaken only after all that can be has been accomplished by mechanotherapy.—*William Arthur Clark, Chicago.*

IX, 2.

IX. CONGENITAL DISLOCATIONS AND LUXATIONS.

The Use of Continued Extension by Means of a New Extension Frame in the Bloodless Reduction of Congenital Dislocation of the Hip. John W. Churchman. *Surg., Gyn., and Obst.*, May, 1919.

The modification of the Lorenz technique which the author brings forth aims to eliminate the risks, while adhering to the principles of the Lorenz technique; and to do this by substituting for the violent manipulations under anaesthesia a rather gradual extension.

A new extension frame has been devised to put extension on the leg in any desired position of abduction and at the same time to keep up any desired type of rotation.

With this extension frame the muscles may be stretched gradually to any desired degree and absolutely without pain; and the head of the femur may be gradually laid into the position desired, purely by the method of extension and rotation, or by these methods supplemented by the slightest possible manipulation of the head of the femur.

After the reduction of the dislocation, the case is treated exactly as indicated by Lorenz.

The extension frame used consisted of a 1¼ inch gas pipe bent into a circle. If abduction beyond a right angle was desired, or it was found that with abduction nearly at right angles, the child overcame this abduction by rising in bed, the extension frame was shifted to the head of the bed. In this position abduction to any desired degree could be obtained. For the production of rotation, straps were attached in the usual fashion and these were led to pulleys which could be attached at any point in the frame desired.

The method here described consists briefly in:

1. Application of extension in the lines of the legs as they rest in their deformed position.

2. Gradual abduction until the legs form with each other an angle of 180 degrees.

3. When maximum abduction has been produced, digital manipulation of the heads of the femurs to drop them into place.

4. Maintenance throughout of rotation necessary to keep the toes pointing directly upward.

5. Gradual reduction of the maximum abduction produced, until the legs form with each other an angle of about 35 degrees.

6. Application of plaster cast from the waist to the knees.

7. Transmission of the body weight to the acetabula, through the head of the femur, by allowing the child to walk.

If a favorable case in a young infant with well developed acetabula is treated in this way, not only will the case be simplified by eliminating the violent manipulations hitherto used, but more accurate results will probably

be obtained because it will be found that the head can in this way be placed at will exactly where one wishes it to lie, and that if the position is, by roentgenographs, shown to be not entirely satisfactory, a change in the direction of the extension or rotation straps will make the desired correction. —*Leo C. Donnelly, Detroit.*

XII. CHRONIC INFECTIONS OF JOINTS AND BURSAE (non-traumatic).

XII, 2, *a*.

Deforming Arthritis of the Hip in the Adult. Beaujard, Roussy, Caillods, and Cornil. *Paris Médical*, February 22, 1919, p. 151.

In all cases of limping and anti-algesic attitudes in which the cause was not obvious the authors made systematic radiographic studies of the hip joint.

Subjects examined were between twenty-five and thirty years of age, without previous infection of the hip and without history of tuberculosis or syphilis. The symptoms usually followed fatigue in the field or rather rarely started with a fall. Because of the localization of the symptoms the patients usually came with a diagnosis of sciatica. The patient stands on the leg opposite the affected side and on walking holds the hip stiff and bears weight on it only for a very short interval. In one case an audible click, caused by subluxation of the head of the femur, accompanied the limp. Abduction and external rotation of the hip is quite usually sharply limited, adduction and internal rotation not so much so, and flexion only slightly limited. Crepitation in the joint is rarely felt in these movements. Percussion over the great trochanter reveals slight pain in the joint. In rare instances there was real shortening (as much as three centimeters in one case) on the affected side. Muscular atrophy was present in late cases and coincordant with this, an exaggerated knee jerk. Hypertonicity with fibrillar contractions of the gluteal muscles is sometimes present.

Radiographic examinations lead to a classification of lesions causing the above symptoms.

Type I. Hypertrophy of the femoral head predominating on the superior-internal aspect. Two varieties of this type are distinguished. In one the angle and form of the neck is unchanged and in the other the neck is shortened and its direction approaches more toward the vertical, thus causing an increase in the angle with the shaft. The head in the second variety may be said to show an exaggeration of the hypertrophy which characterizes the first variety.

Type II. Generalized hypertrophy of the femoral head overhanging the neck on all sides, tending to produce a cuneiform or oval shape. Two varieties are described, which may be only two stages of the same process. Variety 1. Head elongated transversely, with a horizontal upper surface and a more or less vertical inner surface, neck shortened but still visible and at normal angle, acetabulum enlarged, the upper limits of head and acetabulum separated while the lower limits are in contact. Variety 2. Hypertrophy of head very marked, extending even to the trochanters, the neck overgrown by the head and scarcely visible, yet the angle of inclination preserved, acetabulum enlarged and receding from the head at the upper part.

From a diagnostic standpoint the condition studied seems to be distinct from other arthropathies. In coxa-vara the angle of the neck is diminished while in this condition it is either normal or increased. In coxalgia there

is irregular destruction of osseous tissue with decalcification and atrophy. It differs from the tabetic joint by the absence of fractures and from chronic ankylosing arthritis in the absence of osteophytes and presence of hypertrophy.

In classical works one does not find any description of a condition such as this. Recent French literature, however (Calvé and Lamy), furnishes something of a type of pseudo-coxalgia which may be classed with it.

In regard to the etiology, first of all the question of trauma arises: whether the lesion comes from a mechanism similar to that causing coxa-vara, whether a repeated trauma is a factor or whether it results from an unbalanced attitude throwing the body out of plumb. Two obvious objections to this stand out: the deformity of the neck is often a coxa-valga and the age of the patients studied is well past that at which plastic changes in the bones occur. Is it an intermediate clinical form between morbus coxae juvenilis and morbus coxae senilis? Is it morbus coxae senilis praecox brought on by fatigues and hardships of life in the field? Verified answers can not be given to these questions.

The authors are describing a condition which is very similar to what American orthopedic surgeons are accustomed to call hypertrophic arthritis of the hip.—*William Arthur Clark, Chicago.*

XII, 3, and XIII, 2.

Tonsillectomy in Myositis and Arthritis. Results in two hundred cases. H. I. Little, M.D., and H. R. Lyons, M. D. *Journal A. M. A.*, April 26, 1919.

The authors have formed their judgment from a series of cases operated upon for removal of tonsils at the Mayo Clinic. Replies from these 200 persons as to their condition were received during the year following operation.

The estimates of improvement or non-improvement are made from several different viewpoints with fairness and frankness. The operators have acknowledged failures and successes with equal cheerfulness.

Their summary which follows cannot be improved.

SUMMARY.

1. It is justifiable to advise a tonsillectomy in every frank case of myositis or arthritis.

2. A marked improvement may be assured from tonsillectomy alone in 79 per cent. of all cases.

3. It is necessary to remove all possibility of dental sepsis; by so doing a large percentage of patients will be improved.

4. The duration of the myositis or arthritis is a factor in the ultimate results, although benefit and even complete cure is obtained in some long standing, chronic cases.

5. Forty per cent. of the patients with chronic myositis or arthritis who are invalids will respond favorably to tonsillectomy.

6. The size of a tonsil has no bearing on its possibility as a focus of infection. A careful expression of the tonsillar crypts and a history of throat trouble associated or not associated with the myositis or arthritis is essential in the diagnosis.

7. An absence of a history of diseased tonsil in no way eliminates the organ as a focus of infection.

8. A clean tonsillectomy, with the removal of the plica tonsillaris, is necessary in every case.—*H. A. Pingree, Portland Maine.*

XII, 7.

Derangements of Semi-lunar Cartilage of Knee Joint. M. S. Henderson. *Minnesota Medicine*, April, 1919.

The author reviews the anatomy of the semi-lunar cartilages and their attachments and gives the mechanical reasons for the greater frequency of derangement of the internal cartilage. Local symptoms are reviewed. X-rays are of negative value. It is a rule that a knee having but one derangement should not be opened. Should derangement recur, operation is advised. The technique of the operation for the removal of the internal cartilage as practised in the orthopedic section of the Mayo clinic is given. Ninety-eight cases operated in the Mayo clinic form the basis of this paper. The internal cartilage was removed in 94 cases, and the external in 4.—*Edward Z. Holt, Atlantic City, N. J.*

XII, 8.

Perthes' Disease. W. W. Watkins. *Southwestern Medicine*, March, 1919.

This article is a review of the literature of the subject. The condition must be differentiated from arthritis deformans and from tuberculosis.

Arthritis deformans affects the joint cartilage and is early associated with crepitation. Osteophytes and hypertrophic bone formation occur. Possibly some flattening may be present. T.B. causes bone rarefaction and destruction.

In Perthes' disease, the cartilage is not affected. Changes occur in the bone beneath, leading to a softening and flattening of the head. The complex symptoms of Legg, Calvé, Perthes and Brandes are given. The most interesting question is that of etiology. Roberts gives four theories as to cause: (1) traumatism, (2) obscure infection, (3) perverted metabolism, (4) syphilis. He believes syphilis is the cause.—*Edward Z. Holt, Atlantic City, N. J.*

XII, 9.

Two Cases of Intermittent Hydrops Articulorum. H. MacClelland, *Lancet*, March 22, 1919.

Brief histories of two cases are given. The knee joint was involved in both. One occurred in a female, aged 23 years, and the other in a male, aged 60. In both cases recurrent swellings of the joint occurred every 10 or 11 days, lasting from 3 to 7 days. These recurrent attacks extended over a period of several months. Patients were perfectly well for intervals of several months. Local or general treatment in either case was of no avail. Exercises seemed to increase the severity of the attack. There was no history of asthma, Raynaud's disease, or angioneurotic edema. No suggestion as to the cause or the treatment of these cases is given.—*Edward Z. Holt, Atlantic City, N. J.*

XVII. SCOLIOSIS.

XVII.

Treatment of Scoliosis. Dr. Joland. *Paris Médical*, January 4, 1919.

Systematic gymnastics are regarded by the author as indispensable in the

treatment of scoliosis, not only in postural curvatures, but even in fixed cases.

It is urged against gymnastics that considering the short time that is given, say one hour each day, that it can do no good, as the cases have all the rest of the day to fall back in the old position.

Joland thinks this is no just argument against the efficacy of gymnastics, because an hour is too long to put weak children to such an ordeal.

He advocates rather to teach these patients a series of exercises, some of which can be followed out at any time during the day; some of which would scarcely be noticed by outsiders; such as the manner of sitting, lying, standing, the kind of bed, etc.

He attaches much more importance to properly regulated exercises than to mechanical supports, and he insists that if the latter are used they should be frequently changed as gain is made upon the deformity.

Laying aside paralytic and congenital defects, he attributes lateral curvature of the spine to muscular fatigue induced by careless and faulty bearing.

To impress upon his readers the beneficial effects of muscular exercises he relates the case of a young girl who was taught to keep her spine erect despite the fact that she was afflicted with a cuneiform deformity of the fourth lumbar vertebra.

Regularly conducted muscular exercises, persevered in for a long time, in conjunction with Wolf's law, both commenced early, will cure the vast majority of scoliosis cases.

In insisting that muscular exercise is the sheet anchor in these cases, he reasons that since it is admitted that scoliosis has a functional origin it is necessary to throw that function in the opposite direction by throwing the spine to the opposite side by frequent and persistent exercise of the opposing muscles.

He claims that the rapidity of improvement is sometimes surprising and relapses are rare.

When relapses do occur it is generally when the system is below par from illness or other causes.

He insists that treatment should be persisted in for a long time and the patient watched for several years.

In conclusion he says that the treatment of scoliosis by gymnastics restores the normal equilibrium of the spine and corrects the form by an improved function. It overcomes the cause of the asymmetry and works successfully against the cause of the deformity. It equalizes the muscular force and resistance.—*Daniel LaFerté, Detroit.*

XIX. TRAUMATIC CONDITIONS.

XIX, 1.

Post-traumatic Spondylitis. Chuzet. *Paris Médical*, February 1, 1919, p. 92.

Several cases are reported by the author in which injuries of the spine by shell or other trauma have been followed by more or less serious disability. The complicating lesions are usually osteophytic in nature and may be confined to the immediate vicinity of the original injury or distantly removed from it.

One case showed a localized callus bridging from the second to third lumbar vertebra five months after a shell wound of the left lumbar region.

The limited motion of the spine was improved somewhat by physiotherapy but tenderness on lateral bending persisted. Two cases showed rarefaction of vertebral bodies one or two segments removed from the seat of fracture, with pain and limitation of motion, simulating spondylitis. Pain was relieved somewhat by physiotherapy but the flexibility was not improved. In other cases lesions developed quite distant from the fracture. Three of these are reported in detail. One of them showed an exostosis on the third lumbar following a shrapnel wound of the right side of the sacrum, and in another a spondylitis of the first three lumbars progressing to complete ossification occurred after a shell wound between the last dorsal and first lumbar. Thus the complicating disabilities are in some cases worse than the original trauma.

The radiographic images are different from those of the traumatic spondylitis described by Kummel-Verneuil in that there is no kyphosis and the exostoses instead of being confined to the concave side of a kyphos may be found some distance from the seat of injury.

Whatever may be the nature of the trouble it is interesting that the lesions are late developments from definite traumata, occurring at a distance from the original injury. Physiotherapy has been useful in relieving the pain and improving motion. Radiotherapy is also indicated in cases in which pain occurs coincident with development of exostoses.

The author, while not offering any definite conclusions, gives an interesting account of a condition which many have no doubt observed after gun shot or shell wounds of the spine.—*William Arthur Clark, Chicago.*

XIX, 2.

Ununited Fracture of the Patella and of the Olecranon. Fred H. Albee. *Surg., Gyn., and Obstet.*, April, 1919.

The author discusses the treatment of old, ununited fractures of the patella and olecranon. He advises against the bone inlay for a recent fracture and the use of silver wire in all fractures of this nature.

Technique: As in all bone-graft operations on the extremities, a tourniquet is applied to the upper portion of the thigh. The fracture fragments are approached by a U-shaped flap, the apex of whose convexity lies over the ligamentum patellae, its base over the femoral condyles. All fibrous tissue between the fragments is carefully removed: in the case of refractures or fibrous union, the fragment ends are freshened. The fragments are approximated, and the lateral rents in the fibrous capsule are repaired at the sides with interrupted sutures of medium kangaroo tendon. The central portion of the anterior surface of the patella is then denuded of its periosteum and peri-osseous tissues by turning back laterally flaps of these structures on each fragment.

The letter H graft is mortised into the fragments of the patella and held in position by kangaroo tendon sutures.

In fresh fractures of the olecranon, exposure by incision, drilling the fragments, and the insertion of kangaroo tendon for their fixation is believed to be the best method of treatment. In ununited fractures of this process, the inlay graft, held in place by kangaroo tendon, can be easily applied on account of the superficial location of the olecranon, and promises better results than are offered by any other procedure. The graft is inlaid to the tip of the olecranon, on the one hand, and as far into the shaft on the other

as the amount of bone sclerosis indicates. A sliding graft, or one obtained from the tibia, may be used, as conditions indicate; or a peg graft may be used instead of the inlay.—*Leo C. Donnelly, Detroit.*

XIX, 2, *c*.

Recognition and Significance of Fractures of the Patellar Border. Capt. R. W. A. Salmond. *British Journal of Surgery.* January, 1919.

An interesting paper which illustrates the value of well taken radiographs in the proper diagnosis and treatment of obscure lesions about the knee joints, eight cases of fissure fracture of the patella coming for x-ray examination with a tentative diagnosis of synovitis, arthritis, et cetera.

The chief points in this condition are:

1. The difficulty of obtaining a definite history of trauma, though on careful interrogation a story of some slight indirect injury may be elicited.
2. It may be right-sided, or left-sided, or both, according to the exciting cause.
3. The seat of any discomfort or pain is usually on the inner side of the patella, while the fissure fractures observed have been without exception on the outer border.
4. The direction of the line of fracture is either longitudinal, or obliquely downwards and outwards, but not transverse as in the usual muscular fracture.
5. A linear depression may be felt, corresponding to the line of fissure; pressure of the bone on either side of this may elicit separate movement, and generally tenderness, but not crepitus.
6. Synovitis is frequently present, or has been at some previous date, caused partly by the tearing of the synovial membrane with the fissuring of the posterior surface of the patella, and it is prone to recur.—*H. W. Meyerding, Rochester, Minn.*

XIX, 2, *c*.

Reduction of Sub-trochanteric Fractures by Ventral Position. Constantini and Vigot. *Paris Médical,* December 14, 1918, p. 486.

In order to establish and maintain the required position of flexion-abduction of the thigh in cases of sub-trochanteric and high shaft fractures of the femur, the authors have treated three cases by placing the patient in ventral position on a table and allowing the affected leg to hang down by its own weight. The table used has a top made up of small detachable sections. Such of these sections are removed as will permit the fractured leg to hang through, and the good leg to remain flat on the same level with the patient's body. The leg is suspended from the table by means of a strap around the ankle, thus causing a moderate flexion of the knee. The weight of the member helps considerably in effecting the reduction of the fracture. In the cases described, perfect apposition was secured, the compound fractures enabling the operator to actually see the alignment. The position thus secured was maintained by application of a plaster cast. On evacuation of these patients a short time after, the fragments were still in good apposition. In short, "we have obtained very easily, the reduction of a fracture reputed difficult to reduce by utilization of the simple weight of the member."—*William Arthur Clark, Chicago.*

Vol. I, No. 8 AUGUST, 1919 Old Series: Vol. xvii, No. 8

The Journal of Orthopædic Surgery

TWO UNUSUAL COMPLICATIONS IN AMPUTATION STUMPS

BY E. MUIRHEAD LITTLE, F. R. C. S., LONDON

Two cases of which I show radiographs are, I think, rare enough to be worthy of a permanent record.

CASE 1. W. M. Late R. N. D. Amputation right leg 4¼ inches below knee, left leg 5 inches below knee. Admitted to Queen Mary's Convalescent Auxiliary Hospital, Roehampton. Discharged July 30, 1918, wearing on the left stump a No. 8 artificial leg with side steels and knee joints and leather thigh corset. There is no record of the presence of any unusual condition about the knee at this time.

An X-ray picture had been taken in May, 1918, at the Pavilion Hospital, Brighton, the Commandant of which reports that nothing abnormal was then observed except a spur on the fibula.

Patient states that in August, 1918, while walking on the artificial leg he fell and hurt his knee, and the present deformity was then noticed. He suffered considerable pain, and the thigh became swollen and discoloured and remained so for a long time.

On re-admission to Roehampton in January, 1919, he showed the very striking deformity shown in the X-ray print.

The side-steels of his artificial leg were correspondingly deflected.

It will be seen that the external condyle has been fractured and driven upwards and is apparently fixed in its position by newly formed bone, and a traumatic Genu Valgum is the result.

The patient's account leaves the sequence of events doubtful, but it appears most probable that he tripped and fell and that the

fracture was caused by severe side leverage which bent the steels. In short, that the prosthesis acted as a wrench or osteoclast.

At this time, six months after the injury, it appeared unadvisable to attempt any correction of the deformity.

A new socket shaped to accommodate and compensate for the deformity was supplied, the steels, etc., adjusted, and he left the Hospital walking satisfactorily.

CASE II. W. W., late R. E. Admitted to Queen Mary's Convalescent Auxiliary Hospital, Roehampton, on March 3, 1919.

Amputation of right leg 8 inches below the knee on May 30, 1918.

Patient says, that at that time the knee was normal. He states that in October or November, 1918, when walking on crutches he fell, striking first the end of the stump and then the inner side of the knee.

An X-ray picture was taken shortly afterwards and he was told that the kneecap was broken. The knee was kept on a splint for four or five weeks.

On examination nothing abnormal was made out and neither Major Kelly of the Pavilion Hospital, Brighton, nor I could believe that the patella had been fractured in the manner described. An X-ray picture was taken, however, which is now exhibited and shows a transverse fracture of the patella at the junction of the upper third with the lower two-thirds.

In front the edges of the fragments appear to be separated by about $\frac{3}{8}$ of an inch, but they are in contact behind and appear to be united as to the posterior half of the patella by new bone.

The mechanism of this fracture is to me obscure. The patient maintains that there was no loss of the normal range of movement in the knee before the accident, which excludes shortness or adhesion of the quadriceps and shortness of the ligamentum patellae as causes.

He also denies that the knee was bent under him at the time of the fall. Although the fracture resembles the typical one caused by violent muscular contraction, (except as regards separation of fragments) it can hardly have been caused in the usual way by any effort of recovery, seeing that the leg stump was free and therefore offered no sufficient resistance to muscular action.

THE LOOP OPERATION FOR PARALYTIC EQUINO VALGUS WITH REMARKS ON THE PRINCIPLES OF OPERATIVE TREATMENT OF PARALYTIC DEFORMITIES OF THE FOOT

BY ROYAL WHITMAN, M. D., NEW YORK.

The most common of the paralytic distortions of the foot is Talipes equino valgus, caused by the loss of the Tibialis anticus muscle, often combined with complete or partial paralysis of the posticus as well.

In a characteristic case of this type the foot inclines downward and outward. The sole is everted. The head of the astragalus projects on the inner border especially when the Tibialis posticus is paralysed. The great toe is dorsiflexed in a hammer-like deformity and the head of the depressed metatarsal bone is often surmounted by a sensitive callus. The smaller toes are contracted and the salient extensor tendons are displaced outward. Dorsal flexion is restricted by a shortened tendo Achillis, and adduction by the contracted peronei and by changes in the tissues in adaptation to deformity.

The design of the loop operation is to reduce the direct abducting force by removal of the Peroneus brevis and Tertius. To increase that of dorsal flexion by transplanting the Peroneus brevis and Longus hallucis to the inner border of the foot. To lessen the tendency to deformity both directly and indirectly by displacing the dorsal tendons from the outer to the inner side of the foot, where they are retained by looping about them the tendon of the Tibialis anticus and implanting it in the tibia to serve as a supplementary support for the inner border of the foot.

The inward displacement of the dorsal tendons and the means employed to assure it are the original features of the operation.

The order of procedure is as follows: All restriction to adduction and dorsal flexion is overcome as a preliminary measure. This usually requires division of the tendo Achillis. An incision is then made behind the external mallelolus extending upward over the fibula to the junction of the lower and middle thirds. The common sheath of the Peronei is opened and the tendon of the Brevis is freed from its attachments about the malleolus. Its insertion at the base of the 5th metatarsal bone having been cut through a small incision, the tendon is drawn back and its muscular fibres

are separated from the fibula up to the point of transference. A long incision is then made over the centre of the ankle extending from about three inches above the joint downward to the metatarsal region. The tendon of the Peroneus tertius, which restricts inward displacement, is cut at its insertion and separated from the adjoining tendons of the common extensors. These tendons are carefully dissected from the underlying tissues and the annular ligament is cut through so that they may be displaced to the inner border of the foot without tension. The tendon of the Tibialis anticus is divided at its junction with the muscular substance and is drawn downward from out the sheath through a small opening near its insertion. The tendon of the Peroneus brevis is passed through the sheath of the Tibialis anticus according to the Biesalski-Mayer technique, sewed to the attachment of the Tibialis anticus and to the periosteum. The Longus hallucis tendon is cut at the same plane, drawn through an opening in its sheath, and it, together with the tendon of the Peroneus tertius, is attached to the periosteum of the scaphoid. The tendon of the Tibialis anticus is then passed from within outward under all the dorsal tendons and is drawn upward and embedded in a groove running in a direction upward and inward, cut in the inner border of the tibia after the Gallie method at a sufficient tension to hold the foot at a right angle to the leg and slightly inverted. The incisions are closed with two layers of catgut; the first for the repair of the tendon sheaths, and for a subcutaneous covering of the tendons. A plaster splint is then applied fixing the foot in the position above described.

As soon as weight bearing causes no discomfort the patient i encouraged to use the foot in walking. In hospital practice the plaster splint is continued for about three months, but if supervision may be assured, a removable support may be used which will permit exercise of the transplanted muscles in their new function as soon as repair is complete.

As has been stated, locomotion in the overcorrected position until the structure of the foot has in some degree conformed to the new relations, is an important adjunct in treatment, and it would be of advantage if the foot might be fixed in this attitude for several weeks before the operation.

By this method all the muscles of the foot except the Peroneus longus serve in some degree as adductors, and there is therefore but little tendency toward recurrence of deformity. Indeed the

overcorrected attitude is so persistent that the parents often fear a permanent substitution of the opposite distortion.

Gradually the foot resumes the normal position and later the inner side of the shoe may be thickened or a flat foot brace applied if it seems advisable, as in the cases in which the tibialis posticus is paralysed. The most important indication in after treatment is to insure the free range of dorsal flexion by methodical stretching and exercises.

It is evident that the Peroneus longus, because of its greater strength and length of tendon, is more adaptable as a dorsal flexor than the brevis. It is not transplanted, as in the conventional operation, because its normal function is important, since it binds the foot together and supports the first metatarsal bone in walking, while the Peroneus brevis and tertius are simply abductors.

I think it will appear on analysis that in the loop operation little is sacrificed in comparison with the direct gain, a conclusion that has been confirmed by practical experience.

It may be noted that it was for the relief of this deformity that tendon transplantation was revived by Parish of New York in 1892. He simply sewed the tendon of the Longus Hallucis to that of the paralysed Tibialis anticus, the result being immediate success and subsequent failure.

The original transplantation of Nicoladoni was of the Peronei to the tendo Achillis for paralytic calcaneus. This operation is still performed, although comparison of the bulk of the calf muscle with that available to replace it should indicate its practical futility, since voluntary plantar flexion is of little service unless sufficient power is restored to assure resistance in locomotion.

These and similar operations were based apparently, on the theory that a latent force might be counted on to supplement an inadequate or defective mechanical design, an assumption that has not been supported by the evidence. On the contrary the response of latent force, represented by the development of weak and inactive muscles is in direct relation to the opportunity for improved function that the operation assures. An analysis thereof of the degree and distribution of the paralysis and of the resulting disability should indicate fairly the purpose of the operation, the means best adapted for its application and the result that may be anticipated.

The function of the foot is weight bearing and locomotion. Consequently the primary object of operative repair is to assure security, and thus to displace mechanical support.

From this standpoint the relative effectiveness of the methods in common use may be considered.

Tendon transplantation can at best restore muscular balance, for which the removal of the distorting force is of equal or greater importance than the transfer of positive power.

A transplanted muscle does not increase in strength because its new function makes greater demands upon it. On the contrary, it is never as effective as in its normal position, because of the mechanical disadvantage to which it is subjected and because of the loss of a part of its muscular attachment. Thus the actual force at command, though more usefully applied is lessened rather than increased by the operation.

Since then, tendon transplantation cannot restore power but can only rearrange its distribution, it follows that it can be functionally adequate only for lateral distortion and particularly for varus deformity, because in this instance a competent dorsal flexor, the Tibialis anticus, may be changed from an adductor to an abductor without greatly lessening its mechanical efficiency.

As a comprehensive remedy therefore and especially in contrast to the claims made for it, tendon transplantation has proved unreliable and must be supplemented by other means of assuring security.

For the more severe and disabling types of deformity, especially those associated with cavus or calcaneus, the most effective basic operation is astragalectomy and backward displacement of the foot. I am obliged to use this cumbersome title to emphasize the point that simple astragalectomy is of no value whatever. The essential of success is the backward displacement so that the malleoli may overlap the medio-tarsal joint, restraining lateral distortion and preventing dorsal flexion by contact of the tarsus with the tibia. Thus the resistance of the forefoot is restored; a resistance that is essential to normal locomotion when either the calf muscle or the anterior thigh group is paralysed. Plantar flexion on the other hand is retained so that an inoffensive shoe may be adjusted to compensate for the progressive shortening of the limb that is a constant sequence of anterior poliomyelitis in childhood.

This operation has the unique distinction that the greater the deformity and disability the better, relatively speaking, is the result both from the cosmetic and functional standpoint.

Arthodesis at the ankle joint oftener results in an unstable stiffness than fixation—or if ankylosis is attained, increased mobility of the anterior articulations may permit varus deformity. In successful cases the foot is fixed at a right angle or eventually in slight dorsal flexion so that an unsightly cork sole must be worn in later years in compensation for the short limb. This, a point of greatest importance to the patient, has been quite overlooked by the advocates of the operation. From my point of view Arthodesis at this articulation is almost as unsatisfactory when successful as when it fails and I have long since discarded it.

Arthodesis at the mediotarsal or subastragaloid joints for the purpose of preventing lateral distortion is of service in the treatment of older patients but it is rarely effective in the younger class, comprising the majority of the cases, because of the large proportion of cartilage to bone. Bone pegging is simply a reinforcement of arthodesis and in its wider application it is open to the same objection.

Tendon fixation or implantation after the Gallie method is of value as an adjunct, as in the loop operation, but otherwise, in the class of cases under consideration its range of utility is very limited.

Silk ligaments: As a means of assuring permanent stability this procedure has apparently been generally abandoned and the same is true of silk tendons.

Osteotomy: Cuneiform or simple of the foot or limb may be indicated to correct deformity of long standing or to change the line of weight bearing. Fixation of the foot in an overcorrected attitude for a time sufficient to permit adaptative changes in its structure is an important adjunct in treatment. Indeed it is often far more effective than the operation which it supplements.

From this analysis it will appear that there are two procedures to which all others are subsidiary. Tendon transplantation and astragalectomy and backward displacement of the foot, the latter having by far the wider range of practical utility.

In my opinion operative treatment is indicated for all paralytic distortions of the foot and I am inclined to think that it is, at present, delayed unnecessarily. It is true that in certain types of in-

complete paralysis improvement may go on for years and that apparently lifeless muscles may revive after deformity has been corrected. If, however, a muscle or a muscle group which has properly protected shows no signs of regeneration after an interval of two years, operative treatment, if otherwise indicated, need not be delayed. It would seem furthermore that relatively early tendon transplantation should favor functional readjustment, as compared to the later period, especially if the tendon sheaths are utilized to assure freedom from adhesions.

Early operation is advisable also for paralysis of the calf muscle because atrophy and deformity advance rapidly in spite of mechanical support. In these cases astragalectomy and backward displacement of the foot is the only effective remedy, since it alone can assure the resistance necessary for normal locomotion. In this operation tendon transplantation is an adjunct—the Peronei to the tendo Achillis for calcaneo-valgus, the Tibialis anticus and occasionally the posticus to the outer border of the foot, for secondary varus.

The improvement in nutrition and strength of the limb after this operation best illustrates the response of what has been called latent force, because it is the most effective adaptation of the means at command to assure the opportunity for functional repair.

Although the operative treatment of this class of cases has been almost exclusively under orthopaedic control for more than a generation, there is as yet, if one may judge from the literature, no general agreement on its scope or purpose or upon the mechanical principles that should determine the operative design.

In view of the increasing importance of this branch of surgery it would seem that there should be a more definite standard for the guidance of prospective workers in this field, and as a contribution to this end these remarks based on personal experience, are presented for your consideration.

AMBULATORY TREATMENT OF FRACTURE OF NECK OF THE FEMUR.

BY E. H. BRADFORD, M. D., BOSTON, MASS.

Affections of the joint threatening to permanent stiffness are by general usage assigned to the charge of the orthopedic surgeon, and as the serious disability to be dreaded from fractures near the joint is a possible resulting stiffness, the services of a surgeon familiar with the use of various forms of apparatus may often be of service in joint or near joint injuries.

Fracture of the femoral neck is especially an injury to be dreaded, for it frequently leads to permanent and serious disability, not from the fracture which usually unites, nor from the deformity which at the worst does not entail great shortening or flattening of the femoral neck or twist under sensitive treatment, but from joint stiffness not easily overcome and sometimes not overcome at all. The region is not readily accessible by massage owing to the mobility of the lumbar spine; passive motion in after treatment is not effective. Patients usually past middle life are condemned to a crippled condition, with limited locomotion, after weeks and sometimes months of bed and wheel chair confinement and a long period of crutch locomotion.

It is not difficult to surmise the condition of the periarticular tissues accompanying new joint fractures or the series of changes which give rise to the stiffness in cases where no alteration in the articular surfaces of the joint has occurred and before any exostosis has been developed.

The traumatism which breaks the femoral neck will necessarily also tear or bruise adjacent ligament and fibrous tissue in the neighborhood of the joint. This is accompanied by more or less ecchymosis and infiltration of extravasated blood. In the process of healing cicatrization with development of non-elastic fibrous tissue takes place as well as the stiffening of fibrous periarticular tissue, which always follows immobility of a joint, when this is not overcome permanent joint stiffness takes place.

Weakening or atrophy of the muscles necessarily results from disuse with loss of strength necessary to permit unfatigued locomotion when the bone fragments have become sufficiently united to allow the natural weight bearing function of the bone.

The discomfort caused by the periarticular tissue changes is enough to warrant all attempts to prevent or limit their development.

An analogy can be drawn in these periarticular changes with those accompanying chronic joint arthritis with the exception that the latter are slow in development when suppurative and more extensive. Measures however which are successful in checking such tissue changes in joint disease suggest themselves as worthy of consideration in near joint fractures.

The success observed for several years at the Massachusetts Hospital State School for Cripples in the treatment of cases of hip disease, by the aid of the traction and abduction splint developed at the Boston Children's Hospital, has been so noticeable that conclusions as to its value can not well be ignored. Not only have the cases been under careful scrutiny for a long time (several years in some cases) after cure, to establish the permanency of the cure of the bone, but it was also found in many cases that permanent recovery was established with the re-establishment of joint motion, to a degree varying in extent according to the amount of tissue destruction before abduction and traction treatment was begun and periarticular ligament shrinking and stiffening checked or prevented.

With the aid of apparatus, absolute joint fixation is possible without the construction by bandage of the pelvis or trunk. The patient is able to sit up in bed even in the acuter and more painful stages. As there are no perineal straps in the appliance, there is no uncertainty in the extent of the joint fixation which is under the surgeon's control. As the acute symptoms subside the degree of fixation can be lessened under the surgeon's direction, permitting limited and increasing joint motion diminishing ligament stiffening.

Several years ago the writer applied a traction abduction apparatus to a boy of eight with a fracture of the upper third of the femur, after three weeks' treatment in a plaster of Paris bandage. The result demonstrated the fact that a satisfactory securing of the fractured limb was possible with the use of this form of appliance. No subsequent opportunity offered itself when the application of this method of treatment seemed feasible until a year ago, when a domestic at the Hospital School for Crippled Children at Canton, Mass., fell, sustaining a fracture of the neck of the

femur. The woman was of an undetermined age, admitting that she was at least sixty-five years old and not of robust health. It was considered that prolonged recumbency and close confinement would be a severe tax upon her resistance and for a homeless woman a permanently crippled and stiffened hip, preventing any working capacity, would be a calamity. The accident was virtually a life sentence to the hospital and poor house.

The fracture was of the ordinary character of spiral fracture of the neck. There was no fissure into the joint shown in the skiagram. There was an erect upward riding of the femur with eversion of the foot. Crepitus was determined and there could be no doubt of the correctness of the diagnosis of the fracture as the case was carefully examined by Dr. Fish, the Superintendent of the School, and the resident staff, Doctors Daniels and Kemp. She was also examined by a few other competent surgeons who were at the Institution at the time of the accident, present on a meeting of Medical Advisory Draft Board held at the Institution.

On the suggestion of the writer, an abduction traction splint, a form of appliance in constant successful use in the Institution for hip disease, was made and applied to the patient as soon as it could be adjusted. During the two days necessary for the getting the splint ready, the patient was treated by means of weight and pulling traction with sand bags to steady the limb.

As soon as the apparatus was applied the patient was able to be moved about more freely in bed and two weeks after the fracture, was allowed to sit up in a chair.

The abduction traction splint held the limb firmly in an abducted position and (as verified by successive skiagram) the bone fragments in normal position.

The following dates are taken from the Hospital record and are self explanatory:

FELL, SUSTAINING FRACTURE OF THE NECK OF THE RIGHT FEMUR, FEBRUARY 18, 1918.

February 28, 1918—Patient sat up in bed.
March 7—Sat on a couch.
March 12—Stood up in a walking frame.
March 30—Walked with crutches and splint.

April 15—Traction removed, splint retained as permanent crutch.

April 30—Slept without the splint at night.

May 18—Splint taken off altogether.

June 9—Discharged from the Infirmary.

Splint taken off three months from day of fracture.

The patient left hospital for a vacation and reported again in the autumn. There was complete restoration and no shortening.

Later the patient resumed her work at the institution.

FRACTURE DISLOCATION OF HEAD OF RIGHT HUMERUS. AN UNUSUAL CASE.

CHARLES F. PAINTER, M. D., BOSTON.

Mrs. E. R., aet, 46, while coming hurriedly down stairs in a house strange to her, opened a door which led upon a pair of steps down which she fell, striking her right shoulder against a corner. She was seen by a local physician who recognized a posterior, humeral dislocation which he reduced; a subsequent X-ray showed what appeared to be a fragment of bone apparently knocked off from the greater tuberosity of the humerus. A second radiograph of the dislocation showed but little change from the findings above reported. At this point, four days subsequent to the injury, I had opportunity to see the case and had further X-rays taken stereoscopically. The radiographer reported on them provisionally, at my request, while they were still being washed, to the effect that there was an "egg-shell" fracture of the greater tuberosity with a slight displacement of the head of the humerus backward. When the plates were dried, however, the head of the bone was found to be located well down in the axilla rather posterior to the mid-axillary line and certainly 3½ to 4 inches below the upper end of the humerus.

Under ether at the time of operation undertaken for its removal the head of the bone was vaguely palpable in the lower part of the

axillary space. Through an incision about 10 cm. in length started at about 2 cm. above the reflection of the skin of the arm over to the chest when the arm was extended horizontally, the inferior border of the pectoralis major was exposed and the dissection carried bluntly until the brachial artery, nerve and vein came into view. Down behind the vessels the bone could be felt but as it was too risky to try and extract it directly past these structures, so the incision was lengthened both ways and the bone approached from behind, being freed of its connections by finger dissection. The head was delivered intact and showed that the line of cleavage had been directly across the anatomical neck of the bone with very little more roughness of the fractured surface than there would have been had the break been caused by a sharp instrument. The upper end of the humerus was left in contact with the glenoid and later passive motion and massage will be instituted to restore as much as possible the motion at the shoulder joint. The excision of the head could not have been more satisfactorily done had it been formally performed by a master of the surgical technique of this region. The accompanying X-ray shows the relation of the fragment to the rest of the bone and gives a good representation of this rather unique, in my experience at least, accident. The problem of restoring the head of the humerus to its proper place and attaching it there so it would stay seemed to present serious obstacles and the probability that the functional results which might be attained if successful in the technique of restoring the parts to their proper relations would not be better, if as good, as those following a formal excision of the head of the humerus when done for any pathological condition. Accordingly this was the procedure followed. Satisfactory functional result is expected.

CHRONIC SEPTIC INFLAMMATION IN BONE FOLLOWING GUNSHOT WOUND.

BY W. E. GALLIE, M.B.TOR., F.A.C.S., F.R.C.S.ENG., MAJOR, C.A.M.C.

The medical history of this war will show that one of the most difficult problems with which surgeons have had to deal has been the treatment of chronic osteomyelitis secondary to gunshot wounds. That the treatment of this condition has been notoriously unsatisfactory in the past is witnessed by the great variety of treatments that have been advocated, each having its vogue for a few months or years, only to be abandoned because of its failure to accomplish the claims of its originator. The difficulty always has been that in spite of the treatment, a high percentage of the cases did not heal, or if they did heal, repeatedly broke down, leaving sinuses communicating with cavities in the interior of the bones. Sometimes these sinuses have persisted for years with a constant slight purulent discharge and other signs of deep-seated inflammation. At other times they have healed spontaneously, only to recur years afterwards, following the onset of symptoms of acute osteomyelitis. The writer recently had occasion to operate on a soldier who had been wounded in the North-West Rebellion in 1885. His wound consisted of a compound fracture of the middle third of the femur produced by a rifle-ball. Chronic osteomyelitis had persisted for several years, during which time several sequestra had been evacuated. The sinus finally healed, and no trouble developed until a week or so previous to admission to the Military Hospital, when he began to suffer from intense deep-seated pain, with fever and malaise. At operation a drill was passed through very sclerotic bone into a cavity the size of a chestnut, filled with thick pus, and further exploration showed the presence of a shell-like sequestrum.

The usual primary treatment of osteomyelitis has consisted simply of incision and drainage. After the lapse of three or four months, by which time any necrosed bone has become separated, the sinus is enlarged, the sequestrum removed, and the operation completed by curetting the cavity and the sinus and packing the wound with gauze. In the majority of cases this treatment has sufficed, the sinus healing in four, five, or six months, sometimes after the spontaneous discharge of additional spicules of necrotic

bone, or after repeated curettings of the cavity and sinus. Certainly great numbers of soldiers are passing through our base hospitals who apparently have been cured of discharging sinuses by this means.

The Antiseptic Method.

A large proportion of cases, however, have not responded to this simple procedure, and as a result, there has been for many years a search for some method that would materially reduce the percentage of failures. With the introduction of antiseptic surgery the hopes of investigators were raised by the possibility of completely sterilizing the cavities by the use of powerful antiseptics. It became a favourite treatment to open the cavity widely, to clean it thoroughly out with curette and chisel, and to make application of a strong solution of chloride of zinc, or pure carbolic acid followed by alcohol, leaving a tube or gauze-wick for drainage. While occasional good results have been recorded for this method, it cannot be said that it has any decided advantage over the simpler procedure, and in many cases it has undoubtedly done harm by causing a superficial necrosis with subsequent formation of sequestra. The search for an antiseptic which would secure the sterilization of the cavity without injurious effect on the tissues has gone on steadily up to the present day, and there are some writers who are advocating a treatment similar to the above, substituting for the corrosive such antiseptics as eusol, flavine or Dakin's solution. We have given these various methods a fair trial but have been unable to convince ourselves that there is any particular advantage in any of them, or that the use of any antiseptic materially influences the course of the disease.

The Sterile Blood-clot Method.

Based on the observation of Lister, that when cavities are produced subperiosteally in the bones of animals, and are allowed to fill with sterile blood-clot, the clot rapidly undergoes organization, and in the course of two or three months is converted into new bone, several writers, of whom the chief is Halstead, have advocated the careful sterilization of the cavity with strong antiseptic, and the immediate suture of periosteum, muscles and skin, after which the tourniquet is removed and the cavity allowed to fill with blood. Undoubtedly brilliant results have occasionally followed this treatment, the wound healing by primary union and a com-

plete cure resulting. But in the majority of instances the attempt has ended more or less disastrously owing to the profuse suppuration of the wound, and the spread of necrosis in the bone, resulting from the inadequate drainage. It does not appear to be reasonable to expect to secure the perfect sterilization of such cavities by any of the means at our disposal; and without perfect sterility, particularly after the use of antiseptics so strong as to produce superficial necrosis, any attempt to obtain primary union of the wound must be attended by a risk which is out of proportion to the benefit to be obtained.

Other and More Recent Methods.

A modification of the above method has recently been advocated and a number of successes recorded. Instead of treating the wound with strong antiseptic after the thorough removal of scar, sequestra and diseased bone, the area is lightly smeared with the bismuth-iodoform-paraffin paste of Morison, and the wound closed about a narrow rubber drain which is removed after forty-eight hours. Thus the principle of the sterile blood-clot has been eliminated, and the hope of a cure is based altogether on the sterilty of the cavity or on the low virulence of the organisms retained. This treatment is a decided improvement on the method of Halstead as the blood-clot which is so apt to become septic is drained away, and even if the wound does suppurate the presence of the small drain reduces the spread of necrosis in the bone. This method has been successful particularly in those cases in which it was possible to remove the walls of the cavity so widely that the surrounding soft tissues were able to fall into it and so obliterate a space in which fluid could collect. It must be recorded, however, that failures after this operation are frequent, chiefly because of suppuration and inadequate drainage. We have at present no dependable method of foretelling which cases are suitable for secondary suture. The method recently popularized by Carrel, of choosing for secondary suture those cases of superficial wounds which have closely approached sterility, as shown by the bacterial count in smears, is not applicable to septic cavities in bone, as here we have a condition which prevents the preliminary sterilization of the wound. The operation is therefore not likely to reach any degree of popularity, and must be considered for the majority of cases too risky a procedure to be justifiable.

Believing that the explanation of failures in the treatment of chronic osteomyelitis is to be found in the persistence of a non-collapsible cavity, many surgeons have advocated sterilizing the cavity as far as possible, and filling it with absorbable or non-absorbable materials. Thus Hamilton experimented with sponges, filling cavities in the bones of animals with this material, and immediately closing the periosteum and the superficial wound. Microscopic examination at intervals showed the gradual absorption and replacement of the sponge by new bone, and it was said that the process occurred more rapidly than where no sponge was used in the cavity. The principle was then applied to septic cavities after an attempt at sterilization, but the results have not been good. There was the same occasional success with frequent disastrous failures as in the treatments just described. Similarly, other surgeons have used iodoform gauze, antiseptic cotton, such as was formerly used and abandoned by the dentists, catgut, and many other organic substances, and the results were much the same. None of these methods ever attained popularity.

Much the same opinion has developed in regard to those methods which have depended on the obliteration of the cavity by fragments of bone, bone-dust, or the decalcified bone-chips of Senn. The use of such materials was suggested by the fact that when fragments of dead or recently obtained autogenous bone were inserted into sterile cavities in the bones of animals they acted as a scaffold, through which a circulation rapidly became re-established, and were invaded by osteoblasts which absorbed and ultimately replaced them with new bone. Senn decalcified the chips in order that he might pack the cavity more tightly. The use of such materials, however, meets with exactly the same difficulty as confronted the use of sponge, etc., namely, the presence of sepsis in the cavity. Nobody dreams of putting a bone-graft into a case of ununited fracture unless perfect asepsis is assured, and many months are allowed to elapse after the final healing of the wound before such an operation is attempted. The results of the treatment were exactly what might be expected. Occasionally an operation was followed by brilliant success, but in the majority the wounds became septic and had to be opened up and cleaned out according to the general principles governing the treatment of suppuration.

In order to prevent the suppuration which so frequently follows

the introduction of foreign materials into septic cavities, many varieties of antiseptic pastes, gums and wax have been employed. Of these the most widely known is the compound of iodoform, oil of sesame, and spermaceti, advocated by von Mosetig Moorhof. This writer, in 1906, reported a large number of cases treated by this method, with uniformly good results. Such results unfortunately have not been obtained by others and the method is now very seldom used. There has recently been a revival of the search for a suitable antiseptic substance with which to fill the cavity, and some good results have been reported after the use of Beck's bismuth and vaseline paste, and also the so-called B.I.P.P., so strongly advocated by Rutherford Morison in the treatment of wounds. Our experience with these materials has not been satisfactory. Some years ago a series of sinuses leading to bone cavities which had been cleared of sequestra, were injected with Beck's paste. In one case the sinus did heal after several weeks, in fifteen others nothing happened that could be attributed to the treatment, and in three it was necessary to open up the sinus more widely because of interference with the drainage. Our experience with B.I.P.P. has consisted chiefly in operating to remove it from cavities which had been filled with the compound previous to admission to this hospital. The cases usually presented a small sinus with no surrounding inflammation, from which a slight sero-purulent discharge had persisted for months.

The "Flap" Method.

In the last few months several writers have suggested a new principle in the treatment of these cavities which appears to be a considerable advance on the methods already outlined. It has been observed that when the walls of the cavities had been widely removed so that the soft tissues were able to fall into the depression, the wounds healed much more rapidly than where a definite cavity persisted. This suggested the idea of filling cavities which could not be converted into shelving depressions, with pedunculated flaps of fat or muscle. By this means healthy living tissue was introduced, which could not have the disadvantages of the foreign materials. We have given this suggestion a thorough trial and have been very favorably impressed with it. Healing occurs in these cases with greatly increased rapidity. In order that we might study the sequence of the changes more carefully, the flaps were

arranged in several cases so that they could be inspected daily through the superficial part of the wound. After the lapse of three days the flaps are covered with healthy granulations which unite with those which are sprouting from the bones and so assist in obliterating the cavity. The flap assists, therefore, in two ways, first, by reducing by its own bulk the space to be filled by granulation tissue, and second, by acting as a centre from which healthy granulations can grow. It is only in the very large cavities that such an expedient is necessary, as the smaller cavities will heal very nicely without it. It is in the former, however, that one is so apt to see the process of healing by granulations cease after a few weeks, owing to the contraction of deep scar, and in these cases the presence of a core of healthy muscle or fascia is of great value in completing the closure of the wound.

Personal Studies.

In the routine of a study of the repair of bone, some of the experimental studies above referred to, upon which the various forms of treatment were based, were repeated by the writer in conjunction with D. E. Robertson, of Toronto, and some important variations in the results observed. Thus, a series of experiments was performed as described by Lister, in which small fragments were removed subperiosteally from the radii of dogs, and after the periosteal tube had been restored, the cavity allowed to fill with blood-clot. The specimens were recovered at intervals of a week and showed the organization of the clot and its replacement by new bone as described in the original experiment. When the operation was modified, however, by the removal of the periosteum with the fragment of bone, so that no periosteal tube could be restored, and no sterile blood-clot retained, the changes observed in the cavity in the succeeding weeks were practically identical with those described by Lister. The cavity became filled with granulation tissue which grew from the cut surface of the bone, and in the course of eight or ten weeks was replaced by cancellous tissue which gradually increased in density until the normal structure was restored. The obvious conclusion is that blood-clot is of no particular value, even in aseptic wounds, in inducing more rapid filling of the cavities.

In another series of experiments the cavities were filled with sponge, gauze and silk, as described by Hamilton. The results

failed to show that the cavities did fill with new bone more quickly than when they were allowed to fill with blood-clot over which the periosteum had been sutured, or which were simply allowed to granulate from the bottom without the presence of blood-clot.

In both the above groups of experiments, however, an observation was made which is of practical importance. When the fragments were cut from the shafts of the bones, in such a way that they consisted of compact tissue only, the filling of the cavity was very slow as compared with those cases in which the cavity extended to the deep cancellous tissue or the medullary cavity. In the latter the whole excavation became filled within a week with new capillaries and proliferating osteoblasts which could be seen flowing out of the deep portions of the bones. Within two weeks the whole cavity was occupied by a mesh-work of cancellous tissue. This observation is confirmed by other experiments with autogenous bone-grafts in which the bone was transplanted into the muscles of the back. New bone formation always occurred on the surfaces of the graft but was practically confined to the endosteal and periosteal surfaces, and did not appear until late on the cut ends. As pointed out in previous publications, this is due to the presence of free osteoblasts on the endosteal and periosteal surfaces and to their comparative scarcity on the cut ends. This observation is of practical importance in that it indicates the necessity for free chiseling in those cases of old chronic cavities in which the walls have become sclerosed. Fortunately such a condition only occurs in neglected cases, as the walls of cavities which contain sequestra are usually in a state of osteoporosis, a condition which is most favorable to the pouring out of osteoblasts and to new bone formation.

In a third series of experiments the effect of filling aseptic cavities with non-absorbable pastes was studied. Cavities were produced subperiosteally as already described, and filled with molten paraffin, over which the periosteum was carefully closed. The specimens were recovered at intervals up to ten weeks and showed several interesting points. In no case did new bone appear between the paraffin and the periosteum, thus confirming Macewen's contention that the periosteum is only a fibrous membrane and not osteogenetic. Several writers have criticized this experiment, maintaining that foreign materials introduced beneath the periosteum may act as a preventive of osteogenesis. This criticism is

answered by a further examination of the specimens which show that where the cavity has extended to the medullary cavity, the paraffin has become covered with new cancellous tissue which in the older specimens has been converted into compact bone. The only explanation of the difference between the reaction of the periosteum and the medullary tissues to the stimulus of the operation must be that in the case of the reflected periosteum no osteoblasts were present on its deep surface. This view has been confirmed by many other experiments, elsewhere described. These experiments were of further interest in showing the re-arrangement of the structure of the shaft of the bone, in accordance with Wolff's law, to overcome the decrease in strength resulting from the production of a permanent cavity. All the surrounding bone became increased in thickness and in density so that after the lapse of three months, one might say that the shaft was as strong as before the operation.

In this experimental study the methods of Senn and others who sought to close septic cavities by filling them with fragments of bone were investigated. When fragments of autogenous bone are placed in one of the muscles, those cells which are exposed on the surfaces to a supply of lymph immediately proliferate, and in the course of eight or ten days begin to produce new bone. If several fragments are in contact they soon become cemented into one mass by this new cancellous tissue. The transplants themselves become necrotic owing to the absence of a blood and lymph circulation in the minute osseous canals, and as a result the cells in the lacunæ die and ultimately disappear. In the course of a week new blood-vessels grow into the old Haversian canals, and along with them go many osteoblasts which immediately become engaged in the absorption of the necrotic bone. As the old bone disappears, its place is taken by new bone laid down by these osteoblasts, so that after the lapse of two or three months all traces of the old fragments have disappeared and the mass consists entirely of new cancellous tissue. When such fragments are introduced into aseptic cavities in the radii of dogs the same process occurs with even greater rapidity, as there is now an additional supply of living osteoblasts from the exposed walls. No more effective method could be devised of encouraging the filling of aseptic cavities with bone than by using fragmented autogenous transplants. To a certain extent, also, heterogenous and boiled bone fragments are of

value. Although heterogenous and boiled bone, when implanted in living tissues, contain no living cells and are therefore quite devoid of osteogenetic power, they act as an irritant to the surrounding living bone of the cavity wall, stimulating it to osteogenetic activity, and keeping it in this condition for several months, until all the dead bone has been absorbed. In addition, the dead bone, by means of its Haversian canals, provides a scaffold in the same way as does autogenous bone, for the spread of new blood-capillaries and osteoblasts from the surfaces. These osteoblasts immediately become engaged in the absorption and replacement of the implants, with the ultimate result that the cavity is occupied by cancellous new bone. The only appreciable difference between the effects produced by autogenous and heterogenous or boiled bone, is that in the former the whole process is more rapid.

The Infected Bone Wound.

But while such experiments are interesting in showing the effect of such procedures on the normal physiology of bone, they are of little value in leading to a solution of the problem of the closure of the cavities associated with osteomyelitis. Here we are confronted with the additional factor of bacterial infection which completely changes the sequence of events. If any method could be devised of completely sterilizing the cavities, no doubt the same series of changes would occur, with the same gratifying results. But up to the present the weight of clinical experience has gone to show that no certain method of sterilization has yet been discovered, and although occasional successes have led investigators to hope that the problem has been solved, further experience has always led to disappointment. Not only do these methods of filling the cavities with foreign materials fail, in the great majority of cases, to accomplish a cure of the sinus, but they actually constitute a source of real danger in interfering with the free drainage of the wound.

Another fallacy into which one is apt to fall, as a result of depending too much upon experiments on small animals, is that because one finds that small cavities in such bones as the radii of dogs fill readily with bone, one should expect the large cavities resulting from necrosis and osteomyelitis to fill with bone in a similar fashion. Small cavities undoubtedly do fill with cancellous bone, with the ultimate complete restoration of the normal struc-

ture, but it is common experience that large cavities often granulate up from the bottom and finally heal without any marked attempt at new bone formation, and examination of these cases months afterwards with the X-ray shows the persistence of a cavity in the bone. Such cavities are filled with a solid mass of white fibrous tissue, surrounding which is a wall of compact bone, of a density similar to normal cortex. In all probability as the years go on, such cavities will gradually disappear in obedience to the law of growth, but the observation goes to show that the cure of cavities in bone does not depend on the immediate restoration of the normal structure by the laying down of new cancellous tissue.

It would therefore appear that the problem consists of getting these cavities filled with living tissue of any kind, at the earliest possible moment. In the face of the presence of infection this demands the establishment of perfect drainage. Any pocketing of pus will result in retarding the growth of granulations. The more such cavities are opened up and exposed to the air, the better will the granulations grow and the more rapidly will the cavity disappear. In this relation, also, the suggestion that the walls of the cavities should be so widely removed as to allow the soft tissues to fall into them is of importance. By so doing the size of the space to be filled is reduced, and an excellent source of healthy granulations is provided. The suggestion already mentioned, that deep cavities should be partially filled with pedunculated flaps of fascia or muscle, is quite in accord with this principle. Fortunately, the vitality of such tissues is not interfered with by the presence of mild infection.

In the series of experiments above referred to, the fate of such flaps has been studied. Both in patients and in animals, grooves and tunnels have been made in the bones, subperiosteally, and the cavities produced filled with tendon, muscle and fascia, over which the periosteum was sutured. The specimens were observed in the case of the patients, at a second operation, and in the case of the animals, at autopsy, at intervals of from two months to several years. In each case the muscle, tendon or fascia was firmly united to the bone by fibrous tissue; the groove or tunnel still persisted as at the time of the operation; and the bone surrounding the implanted soft tissue had thickened and increased in density sufficiently to restore the normal degree of strength. A point of special

interest in these specimens was that in no case had bone appeared between the periosteum and the implanted tissue.

The anatomical and pathological considerations upon which the treatment of chronic osteomyelitis at the Military Orthopædis Hospital, Toronto, and the Granville Canadian Special Hospital, Buxton, is based, can be reviewed briefly.

The shaft of a long bone consists of periosteum, compact and cancellous bone, and marrow. The periosteum is a fibrous membrane in which the blood-vessels to the superficial layers of the bone ramify before entering the Haversian canals, and through which pass the large nutrient vessels on their way to the medullary cavity. It therefore follows that stripping of the periosteum will interfere more or less seriously with the circulation in the bone, depending on the size and the number of the blood-vessels destroyed. When this occurs in an aseptic field, as in simple fractures, or during clean operations, or in compound fractures that do not become infected, no gross disturbance results, and it has been customary to suppose that no important pathological change has occurred in the portions of bone so denuded of periosteum. That this is an error is witnessed by the fact that the rapidity of union of simple fractures is frequently inversely proportional to their severity; that union following operations on simple fractures, in which the periosteum at the ends of the fragments has been extensively reflected, and plates or wires inserted, is often greatly delayed; and by the observations of Robertson and the writer that following the stripping of the periosteum over even small areas of the shafts of the bones of animals, coagulation of the blood in the Haversian canals occurs to a considerable depth, and the lacunar cells which derived their nutrition from these blood-vessels become necrotic and slowly disappear. This superficial necrosis is by no means extensive and usually gives rise to no clinical symptoms, as the circulation rapidly becomes re-established and the necrotic bone is quickly absorbed and replaced by normal bone.

Very different is the fate of similar necrotic areas of bone in the presence of sepsis. In this condition no re-establishment of the circulation takes place, and no invasion by osteoblasts from the neighboring living bone. If the drainage of pus is sufficiently free to allow the acute inflammation to subside and so terminate the spread of the destruction of the circulation, the residual septic irritation along the edges of the necrotic bone stimulates the osteo-

blasts in the surrounding living tissue to greatly increased activity, with the result that absorption of the living bone takes place until a zone is produced about the dead bone which is occupied only by granulation tissue, which, by a process of ulceration on the surface next the sequestrum, undergoes liquefaction, and so allows the latter to become free. Here it remains for months or years unless extruded by muscular action or removed at operation. By keeping up a constant irritation and by harboring a mild infection it usually prevents the healing of the sinus, or, if healing does occur, causes recurring attacks of more acute inflammation.

Both in the case of aseptic necrosis produced by disturbance of the periosteum and of septic necrosis produced by the spread of infection or by destruction of the circulation by mechanical means, coincident with the introduction of infection, changes of great importance occur on the surface of the necrosed area. On the surface of the bone, particularly in young animals, are many osteoblasts which were formerly supposed to belong anatomically to the periosteum, but which have been shown by Macewen, many other writers and ourselves, to be more properly classified as belonging to the bone. Whenever necrosis occurs in the underlying bone, without the accompanying destruction of these cells, they are immediately stimulated to activity, as are all osteoblasts in the neighbourhood of the necrotic tissue. Thus, when the periosteum has been stripped from an area of the shaft of the radius of a dog, under aseptic precautions, and either sutured back in its former position, or completely removed, these cells, which during such manipulation remain on the surface and in the irregularities of the surface of the bone, undergo rapid proliferation, and soon form a layer of cancellous tissue. In septic necrosis, if the infection is very virulent, or the evacuation of the pus long delayed, these superficial osteoblasts also undergo necrosis and no such new bone formation occurs. This is sometimes seen in cases of acute idiopathic osteomyelitis in children, the whole length of the shaft of the bone being destroyed, and no evidence of regeneration ever appearing. In the majority of cases, however, many of these cells survive, and after the acute inflammation has subsided, undergo rapid proliferation under the influence of the irritation of the underlying necrotic tissue and the mild infection. Some of the cells which are farthest removed from the source of irritation, that is, those that are most superficially placed, and which are there-

fore in closest relation to the periosteum, begin to produce new bone, and before long the whole surface of the sequestrum, except opposite one or two cloacæ through which drainage takes place, becomes covered with a thick layer of spongy bone called the involucrum. Between the involucrum and the sequestrum there persists the same zone filled with granulation tissue, the inner surface of which is in a state of ulceration, as occurs at the line of demarcation. This appearance of a layer of new bone subjacent to and attached to the periosteum has been one of the strongest arguments in favor of the theory that the periosteum is osteogenetic.

In addition to the changes described as occurring in the immediate neighbourhood of areas of necrosis, the whole of the neighboring bone within a radius of several inches may undergo inflammatory change. In the case of aseptic necrosis such as that produced by cutting out a piece of bone and then replacing it, this is slight, and cannot be detected beyond a distance of half an inch from the edge of the dead bone. But in osteomyelitis it may involve the whole of the remainder of the shaft, depending on the extent of the original necrosis. Thus, rarefying osteitis extending a long distance from the necrotic focus can be demonstrated, and the whole shaft over such areas becomes thickened by the deposit of spongy new bone. It is very evident, therefore, that mild septic infection is the greatest stimulant to bone repair. This is demonstrated clinically by the great masses of new bone that form in relation to septic compound fractures and by the spurs and irregular masses which develop at the ends of the septic stumps.

Another pathological change of great importance often occurs in these cases of chronic osteomyelitis, after the irritant has been removed. The osteoblasts which have been enormously increased in number throughout the whole of the inflamed area have hitherto been employed in the rarefaction of the neighbouring bones. They now revert to their adult function of bone-production, with the result that previously soft cancellous and vascular bone becomes exceedingly hard, compact, and correspondingly anæmic. Thus, a cavity left in the shaft of a bone after the removal of the sequestra may gradually have its walls changed from soft cancellous bone to bone of flinty hardness, and the change from vascularity to anæmia in the walls has a great deal to do with the small tendency that such cavities have to heal. Similarly, after the evacuation of sequestra from septic non-unions, the ends of the bones may become so in-

tensely sclerotic that there is little tendency to union after any form of operation, the reason being that the outpouring of osteoblasts from the ends of the fragments is so slight that bony repair cannot successfully bridge the gap, and the space fills again with fibrous tissue.

The role of the marrow in the growth and repair of bone seems to be much the same as that of the periosteum. It does not contain many osteoblasts, these being confined to the layer of cells known as the endosteum, which lines the irregularities of the medullary surface. Its function, considered surgically, consists in acting as a medium for the distribution of the blood-vessels to the Haversian canals of the deep portions of the bone. It follows therefore that damage to the circulation in the marrow will produce changes in the deep layers of the bone similar to those already described in the subperiosteal layers, after destruction of the circulation in this locality. We have recently been able to demonstrate such changes in a case of acute hæmorrhagic infantile scurvy in which the stripping of the periosteum of the tibia involved its nutrient arteries. Sections of the bone made three months afterwards showed the deep layers of the bone, as well as the superficial, to be necrotic, the cells having disappeared from the lacunæ, and the bone undergoing absorption and replacement by cells which had invaded it along with blood-vessels from neighboring living tissue.

Clinically we see a demonstration of these fundamentals in the character of the sequestra which result from various types of wounds. Thus, in compound fractures and in amputations in which there has been acute infection, more particularly if drainage has not been provided early, one is apt to find sequestra form at the expense of the medullary surface of the shaft, indicating the spread of infection and destruction of the circulation in the marrow. All are familiar with the cone-like, tapering sequestra that can sometimes be pulled out of the ends of the septic stumps. On the other hand, in those cases in which stripping of the periosteum has been a feature of the condition, such as in acute idiopathic osteomyelitis, or in operations on the long bones in which the periosteum has been freely reflected and sepsis has been present or has supervened, the sequestra always consist of flakes separating from the periosteal surface of the bone. As in the case of the tubular sequestra which often separate from the medullary surface of stumps that have been septic, we are quite familiar with the circular sequestra

which are pulled off the outer surface of the ends of bones from which the periosteum has been reflected during the operation.

The Principles of Treatment.

From the above considerations may be drawn certain conclusions which may be used as a basis for establishing principles of treatment. We know that healing never occurs in the presence of septic necrotic bone. Therefore every effort should be made to prevent the development of necrosis, and if this misfortune has already occurred, to get rid of the sequestra at the earliest possible moment. As pointed out above, necrosis results from destruction of the circulation to portions of the bone, either produced mechanically or by the spread of sepsis. As a preventive of necrosis, therefore, in cases that have been infected, or which may have been infected, it is of the utmost importance that free drainage be provided. It is just here that those treatments which aims at a cure of chronic suppuration by the sterilization of the field, followed by closure of the wound, with or without the use of foreign materials to fill the cavity, fail. When suppuration occurs, as is very frequently the case, the back pressure is sufficient to produce a further spread of necrosis, and complete failure is the result. Another two or three months must elapse before the new sequestra separate and before the patient is ready for another attempt at a cure.

In those cases in which necrosis has already occurred after an acute infection, no treatment is possible until the sequestrum has separated, further than to provide for efficient drainage. Those surgeons who have fondly hoped that by an extensive subperiosteal resection, the whole of the diseased area could be removed as soon as the acute sepsis had subsided, and that the shaft would be restored by regeneration from the periosteum, have, in the majority of instances, been rewarded by a persistent non-union, there being no effort at restoration of the shaft except at the extremities of the fragments. This idea was based on the faulty premise that the periosteum is osteogenetic, a theory which has been amply disproved by experiment, and by the frequency of the disastrous results that have followed its clinical application. If one closely examines the reports of the cases in which claim has been made that restoration of the shaft has followed extensive subperiosteal resection, it will be found that, as a rule, the operation was performed after sufficient time had elapsed for marked proliferation

of the subperiosteal osteoblasts to have occurred, and usually for the formation of involucrum to be well established. Under such circumstances restoration may sometimes occur owing to reflection of these osteoblasts and new spongy bone with the periosteum. Even such operations as these, however, have nothing to recommend them, as no time is saved, and the danger of non-union and deformity is very great. In our teaching, the operation of subperiosteal resection, both immediate and delayed, is strongly condemned.

When once the sequestrum has become completely separated—a process which occupied approximately three months—radical treatment is urgently called for. This is the time when the reparative process in the bone is at its greatest height. The whole area is in a state of rarefying osteitis, with actively proliferating osteoblasts and blood-vessels, and with rapidly growing spongy bone on the surfaces. Further, the treatment must be such that the healing of the cavity shall be complete before the onset of sclerosis in the bone surrounding the cavity shall have advanced sufficiently far to interfere with the vitality of the growing granulation tissue.

In the majority of instances a cure results from the removal of the sequestrum or from the removal of the sequestrum plus a curetting of the cavity. In many cases, however, this is not sufficient, the sinus persisting indefinitely, and as the months go on, becoming more and more difficult to cure. This is sometimes due to the incomplete removal of the sequestra, sometimes to insufficient drainage, and sometimes to the great size of the rigid walled cavity which makes it impossible for the granulation tissue to completely fill it, owing to the anæmia of the surface granulations produced by the contraction of the deep scar. In our experience the frequency of these causes is in the order named.

To make sure of the complete removal of the sequestra it is necessary that the whole of the cavity shall be explored, and this means that it must be clearly seen. To accomplish this, the whole wall of the cavity nearest the incision must be removed with chisel and mallet. When this is done one is often surprised to find the great extent and irregularity of the cavity, and it is readily seen how simple curetting would usually fail to get out all the dead bone. The utmost care is taken to avoid disturbing the periosteum. This is neither reflected from the bone nor are the soft tissues reflected from the periosteum more than is absolutely essential, otherwise

superficial scales of necrosis are sure to form and lead to persistent discharge. The chisel is applied to the outer surface of the periosteum and the wall of the cavity cut out cleanly. This same principle is applied to the re-amputation of stumps where infection of the wound is a possibility. Without a doubt, reflection of the periosteum would cause no harm if the whole of the bone underlying the area reflected were cleanly chiseled out, but it is difficult to accomplish this and it is better avoided. Since we have taken these precautions we have never had a sequestrum develop after operation.

To reduce the size of the cavity to a minimum and to allow it to fill with normal soft tissues as far as possible, the incision is extended through normal skin and muscle in both directions and the chisel again applied so as to convert the cavity into a crater or a simple depression. In this way, half the thickness of the femur, tibia, or humerus, is sometimes removed over a distance of six inches or more. Every crevice, pocket or tunnel is freely opened up until the whole cavity is converted into a more or less smooth depression and every particle of loose bone removed. The tourniquet is then removed and hæmorrhage controlled by clamp, ligature and pressure.

We believe the greatest importance should be attached to the method of closure and the treatment of the wound. Recognizing that insufficient drainage is the cause of most disasters and failures following such operations, we make it a point to leave very large openings for drainage. The fascia and skin are closed at the extremities with silk-worm gut and practically always heal by primary union. The central portion is left widely open, however, so that the whole cavity can be inspected from the surface. If muscles and fascia tend to close together over the opening, unless the cavity is a very shelving depression, the transverse diameter of the wound is freely enlarged by making a wide window through the muscle and fascia and by cutting a similar opening in the skin. Often this is unnecessary in subcutaneous bones, as the excision of the scar to the periosteum leaves a sufficiently wide area exposed. We have a rough rule that the diameter of the drainage wound at its narrowest point shall be equal to half the depth of the bottom of the cavity. By this precaution we are able to inspect the bottom of the wound during the daily dressings, the whole cavity is exposed to the air like an ordinary superficial healing ulcer, and no pocket-

ing of pus, the sure precursor of complications, is possible. Time and time again we have seen operations performed as above, except that the wound was closed around a quarter or half inch rubber tube or a wick of gauze, end in failure or long-delayed healing owing to the premature closure of the sinus, with a resulting pocketing of discharges. Before the application of the dressings the cavity and outlet are packed with iodoform gauze to prevent hæmorrhage. The packing is removed in forty-eight hours, and as a rule there is no sign of septic inflammation, the sutured portion of the wound healing by primary union and the cavity granulating up from the bottom. This process can be observed day by day, and it is most gratifying to watch the cavity fill up with healthy granulation tissue with only a serous exudation. Before long the wound has become merely a superficial granulating surface, and as a general rule has healed with a remarkably small scar in less than two months. The granulating cavity is lightly packed with fresh gauze every twenty-four hours.

It has been a matter of great interest to observe how uniformly these cases can be operated upon as described, with free incision through healthy muscles and fascia, in spite of the presence of fairly profuse suppuration, without subsequent general or local evidence of acute infection. It is quite the rule for the sutured portion of the wound to heal by primary union, and for granulation to progress steadily without suppuration. The only precaution observed has been that the cases shall not be operated upon when there is local or general evidence of acute inflammation. Preparatory to operation the wound is rendered as clean as possible, and in this connection I wish to pay tribute to the value of an apparatus with which you are all familiar, namely, Captain Taylor's liquid-tight closure apparatus. For two days preceding the operation this apparatus is applied to the wound, ten per cent. salt solution being employed, and we believe it has been helpful in reducing the number of subsequent inflammatory reactions, in spite of the fact that the sinuses are narrow and tortuous, and sequestra are present in the cavity.

Liquid-tight Closure.

It must be recorded, however, that occasionally an acute infection of the wound does occur, with redness, swelling and profuse suppuration. It is in these cases, particularly that Taylor's ap-

paratus has proved of the utmost value. No treatment that we have tried, be it fomentation, Carrel-Dakin irrigation, or the application of flavine or dichloramine T has been nearly so effective as the liquid-tight closure treatment with ten per cent. salt solution. As soon as evidence of acute inflammation is apparent the rubber tank is applied with a head of fluid of about one foot and a syphonage from the bed to the floor, and the ebb and flow alternated by two hours positive pressure and fifteen minutes negative. In no case has it been necessary to continue the treatment longer than seventy-two hours, the wound having returned in that time to the condition of quiescence already described, and healing continues as before.

The experience on which these conclusions have been based has covered upwards of five hundred cases of chronic osteomyelitis, under treatment in the Military Orthopædic Hospital in Toronto, and the Granville Canadian Special Hospital at Buxton. The last one hundred cases have been accurately observed and recorded for the purposes of this report. In no case has there been a fatality or any alarming symptom. In all except six cases healing was complete within three months, and in all except fifteen, within two months. The majority were closed in six weeks. In not a single one of these healed cases has the wound broken down, or has further sequestrum formation developed while the cases were under observation. This period of observation has admittedly been short, but the uniformity with which the wounds have healed from the bottom, without the presence of a sinus leading to bone, gives rise to a strong hope that the condition has been permanently cured. The six cases which must be recorded as failures were noted at the time of operation as unlikely to result in cures, owing to the great extent of sequestrum and cavity formation, and the impossibility of performing at one time an operation which could fill all the requirements as outlined. These cases have required or will require further treatment before healing can take place.

Septic Non-Union.

Of even greater interest have been the observations made on the subject of non-union in fractures produced by gunshot wounds and complicated by septic infection. The most striking feature has been the remarkably small number of ununited fractures that have been admitted to these hospitals, to which the majority of such cases

must come. We were formerly taught that septic infection of compound fractures was a potent cause of non-union. The study of this series of compound fractures has led us to think that such a belief is not exactly the truth, and, indeed, that the very reverse is frequently the case. The way in which enormous masses of spongy new bone form around the areas of these fractures and about the ends of septic stumps, cementing together all sorts of irregularities of alignment and even bridging great gaps in the bone, is ample evidence that sepsis is a strong stimulant of osteogenesis and an assistant to union. It therefore seems clear that chronic sepsis by itself is not the cause of delay or absence of healing. Further investigation has shown that in each case some definite factor, other than the sepsis was present. In the majority, it has been the complete destruction of whole segments of the shaft, so that gaps have existed which could not reasonably be expected to become bridged over. In the others the ends of one or both fragments consisted of necrotic bone which either mechanically prevented the junction of the callus growing from the healthy bone beyond, or which, by the constant irritation of its presence, prevented the return of the osteoblasts in the neighborhood to their adult functions of bone-formation, until the area was occupied by fibrous tissue which acted as a mechanical preventive of union.

With our experience of the freedom with which extensive operations can be performed on cases of chronic osteomyelitis, the principles which should govern the treatment of septic non-union are at once apparent. If it is true that mild infection is at a certain stage favourable to osteogenesis, that is the time when every effort should be made to get rid of those factors which are preventing the union. This time appears to be between three and five months after the fracture. It has become our practice, therefore, in all suitable cases to excise the sinus and scar as before described, to chisel the walls of the cavities away, to remove sequestra, to freshen the ends of the fragments, and to fit them together as accurately as possible. Advantage is taken of all irregularities of the bones to secure and maintain close apposition. Usually this is accomplished without any form of internal fixation, but if it is necessary, the fragments are fastened together with a kangaroo tendon suture passed through small drill holes. The wound is closed at the extremities, and a very large opening, directly opposite the fracture,

is left for drainage. For the first week after the operation the limb is immobilized as well as possible in an ordinary splint which allows of the free removal of blood-soaked dressings, and permits the use of the Taylor apparatus, if required, after which a fenestrated plaster bandage is applied.

Such a method of treatment is applicable to all cases in which the ends of the fragments can be brought together without necessitating so much shortening that the function of the limb would be too seriously interfered with. Thus it is particularly applicable to the humerus which can be shortened several inches without interfering greatly with the usefulness of the limb. This is true to a more limited extent in the case of fracture of the femur and fracture of both bones of the forearm and leg. When the failure to unite has been due to destruction of long segments of the shafts, however, or when the non-union resulting from a moderate gap is confined to one of the bones of the forearm or leg, one must be content to direct the treatment solely to the osteomyelitis and to reserve the restoration of the shaft to a bone-graft operation at some later date.

The recognition of these facts changes the whole aspect of the treatment of non-union. Formerly we were content to devote our attention to the simple healing of the wound, postponing the treatment of the fracture for many months, until a clean operation could be safely undertaken. Now we are able to reduce the duration of treatment in some cases by nearly a year, as we are attacking the condition when osteogenesis is at its maximum, and avoiding the period of sclerosis which is so inimical to repair.

Since the introduction of this plan of treatment into these hospitals, twenty-one cases of septic non-union have been operated upon. Of these seventeen were of such a type that when the sequestra and fibrous tissue had been removed, the ends of the fragments could be brought into some sort of contact with each other. In the other four, such large gaps were present that there was no hope of obtaining union without subsequent bone-grafting. Of the seventeen cases we know that eleven have united within ten weeks of the operation; three have united after the lapse of four months; and three have been failures owing to slipping of the fragments or incomplete removal of sequestra.

Septic Mal-Union

One other feature of the treatment of these septic bone cases is deserving of consideration. A good many patients are admitted who have had septic compound fractures which have united in faulty position. Formerly it was our custom to confine our treatment to a cure of the osteomyelitis and to postpone the correction of the deformity until an osteotomy could be performed in a guaranteed aseptic field. This plan had two disadvantages; first, that it delayed the period of treatment for at least a year, and second, that there was always the very grave fear of non-union occurring if osteotomy were performed through the sclerosed region of the fracture. Since our recognition, however, of the principle that mild sepsis is a powerful stimulant to osteogenesis, we have not hesitated to drive a chisel through the ensheathing callus of the fracture and correct the deformity at the same time as we are treating the osteomyelitis. The precaution is taken to see that in the new position of the bones there is actual contact of spongy new bone. This operation has been performed on six occasions, and each time with rapid reunion of the fragments and uncomplicated healing of the wound.

While these latter cases and the ordinary cases of non-union have been difficult to splint efficiently and at the same time allow daily dressings, we have never yet yielded to the temptation to introduce foreign bodies into the wound, such as wires, plates and screws. Many cases have been bequeathed to us by other hospitals in which such operations have been performed. In no case has a successful result been observed, and in all there has been definite injury in the form of persistent suppuration and increase in the area of necrosis.

Conclusions.

In conclusion, it may be of value to recapitulate the principles which have already been outlined.

(1) The periosteum is the medium by which the blood-vessels are distributed to the shafts of the bones. Reflection of the membrane produces superficial necrosis and should never be done when sepsis is present or feared.

(2) The periosteum as reflected in an ordinary surgical operation is merely a fibrous tissue membrane and is not osteogenetic. It should, therefore, never be relied on to restore the shaft after resection.

(3) Mild chronic septic infection is a strong stimulant of inflammatory osteogenesis. It causes widespread osteoporosis, increased vascularity, and abundant callus-formation. This is the state in which cavities are most apt to heal, and fractures to unite, unless prevented by some definite condition such as the presence of sequestra or the existence of too large a gap.

(4) When the irritation subsides or disappears, this rarefying osteotitis gives place to an intense sclerosis which is very inimical to the healing of cavities or the union of fractures.

(5) Treatment should therefore take advantage of the pathological condition which is present at the time the sequestra have separated, and aim at a complete cure before osteosclerosis has supervened. It should consist of the complete excision of the scar and sinus, and the wide removal of the walls of the cavity for the purpose of thorough evacuation of sequestra and unhealthy granulation tissue. All irregularities and pockets must be obliterated, and when possible the depth of the cavity should be reduced by allowing the soft structures to fall into it. Pedunculated muscle or fascia-flaps are of great assistance in promoting rapid healing. Finally, wide-open drainage must be provided so that the cavity can heal from the bottom without depending on the dangerous alternative of a narrow sinus.

(6) Taylor's apparatus is useful in cleansing these wounds before operation and is of great value in the treatment of post-operative sepsis.

(7) Non-union in compound fractures, uncomplicated by great loss of bone, is rare. When present, the fact that the wound is septic is no contra-indication to active treatment of the fracture, as well as of the osteomyelitis. Gratifying results may be anticipated from thorough freshening of the ends and adjusting of the fragments, providing efficient drainage is secured.

(8) The best time to correct mal-union in septic cases is at the time of the operation for the cure of the disease in the bone.

OSTEOCHONDRITIS OF THE HIP

PERCY WILLARD ROBERTS, M. D., NEW YORK.

In November, 1917, the writer reported two cases of osteochondritis of the hip, variously known as Perthes' Disease, Legg's Disease and "quiet hip disease," in which there was direct evidence of inherited syphilis and rapid relief of symptoms following the administration of mercury and potassium iodide. Since then eight more cases have been added to the series, making ten in all. The indications presented by these that osteochondritis of the hip may be of syphilitic origin prompts this additional report in the hope that it may stimulate others to further investigation of the probable luetic etiology of this condition, and particularly to observation of the effect of vigorous antisyphilitic treatment.

As previously pointed out, the pathologic findings reported by Perthes coincide with one of the most common expressions of bone syphilis encountered in young children, namely, osteochondritis. Lesions of this nature occurring in the region of the knees, wrists and ankles were described many years ago by Parrot and others, and are referred to in every text book which treats of the much neglected subject of bone and joint conditions due to inherited syphilis. The course of osteochondritis of the hip is similar to that of the same process elsewhere in its tendency to spontaneous recovery with good function, and the usual lack of acute symptoms, which led to H. L. Taylor's designation of "quiet hip disease," forms another link of resemblance to osteochondritis of the wrists, knees and ankles.

Again, we often find in subjects with osteochondritis of the hip dental evidence of inherited syphilis. Not, necessarily, the hutchinsonian teeth, but various forms of hypoplasia of the enamel which Cavallaro so convincingly argues are due to fœtal infection by the treponema pallidum.

The contention that the frequency of negative Wasserman reactions in these cases precludes the probability of their syphilitic origin is not well founded. Serologists of experience agree that the blood of syphilitic children often fails to give a positive reaction with alcoholic antigens and that even with the use of cholesterin negative results occur not infrequently. In the writer's experience this has been confirmed many times in cases where the

family history was positive and where existing lesions cleared up under mixed treatment. Of the eight bloods examined in the series reported below one gave a four plus reaction, one a three plus, two gave a two plus, three a one plus and one was negative. A positive family history was obtained twice.

The impressive feature of these cases was the rapid recession of existing symptoms and the prompt increase in hip motion following the administration of mercury and potassium iodide.

Case Reports.

Case 1. Girl aged 8. In July, 1914, had pain in right hip and limped. Treated at two orthopedic clinics for tuberculosis of hip, wearing plaster spica. Wasserman December 4, 1915, negative. Came under observation March 21, 1917, wearing spica. Hip extremely sensitive, very little motion. Radiograph showed typical osteochondritis. Spica again applied; prescribed Hydrarg. Chlor. Corr. Gr. 1-64, K. I. Grs. iii three times a day. One week later plaster was removed and hip was less sensitive and more freely movable. Improvement continued and in ten weeks thigh could be flexed to a right angle. Child was very active, very little limp. Wasserman January 29, 1918, four plus. Father confessed to syphilis before marriage and a Wasserman taken April 10, 1918, was four plus.

Case 2. Girl aged 11. Had had hip symptoms for a year and three months when she came under observation, May 2, 1917, limped in walking, favoring right hip. Flexion of the thigh could be carried to ninety degrees before eliciting spasm; no abduction, no rotation. The teeth showed evidence of congenital syphilis and child was placed on mixed treatment. In two weeks there was less spasm and greater range of hip motion. In four weeks hip could be flexed to forty-five degrees less than a right angle, spasm had almost disappeared, child was very active. In ten weeks there was practically normal flexion and rotation, no limp. X-ray showed typical osteochondritis of right hip. Wasserman one plus.

Case 3. Boy aged 10. Treated two years for Perthes' disease wearing spica most of the time. Symptoms more acute than is usual in this condition. Radiograph typical of osteochondritis. April 29, 1918, extension of hip was limited to 165 degrees, flexion to 130 degrees. Any attempt to carry the thigh beyond these limits brought tears to the boy's eyes. Rotation of thigh blocked; no

abduction nor adduction. Short spica reapplied, mixed treatment ordered. Three weeks later thigh could be fully extended and flexed to a right angle without pain. There was about twenty degrees abduction, free rotation in extension, some with thigh flexed. Spica omitted. After ten weeks of mixed treatment thigh could be flexed to within ten degrees of normal, patient walked without limp and had fairly free rotation and abduction. No Wasserman was made. Father had syphilis before marriage.

CASE 4. Boy aged 9. Symptoms for one year. First treated for rheumatism then for tuberculous hip. Wore plaster spica six months. Hip stiff, marked limp. Placed on mixed treatment. In five weeks the patient was playing ball and was very active in all boys' games. Hip motions somewhat increased. Recovery proceeded without interruption. The blood in this case was negative.

CASE 5. Girl aged 5. Bilateral disease with both epiphyses nearly obliterated. Wasserman two plus. In this case one-half grain doses of hydrargyrum cum creta were given with ten grains of potassium iodide three times a day without satisfactory results. When one-sixth grain doses of mercury protiodide twice a day were substituted improvement was rapid and continued until nearly normal function was regained in three months.

CASE 6. Girl aged 6½. Osteochondritis of right hip. Dental evidence of syphilis; Wasserman one plus; typical X-ray; no special features; normal function in four and a half months.

CASE 7. Girl aged 5. Osteochondritis left hip; typical X-ray; Wasserman one plus; child did not return for treatment.

CASE 8. Girl aged 8. Symptoms for one year. Treated first for tuberculosis of hip, later for Perthes' disease. Wore plaster spica or braces until four weeks before coming under observation April 23, 1918. Child then walked with marked lurching limp. Flexion of thigh checked by sharp spasm at a right angle. Rotation in flexion and also abduction of thigh considerably limited. Radiograph typical of osteochondritis. Dental evidence of inherited syphilis. Wasserman not taken. Family history negative except that grandfather died of "something like tuberculosis" and one uncle had some form of mental disease. Prescribed protiodide of mercury grain 1-6 three times a day. Two weeks later limp was less marked, flexion of thigh had increased thirty degrees, rotation improved, abduction still limited. Five weeks after beginning of

treatment limp was scarcely noticeable, child extremely active, flexion, rotation and abduction of thigh nearly normal, no muscular spasm.

CASE 9. Girl aged 8. Hip symptoms of mild degree appeared in 1914 and continued more than three years, with complete functional recovery except very slight limp. Radiographs typical of osteochondritis of hip. No active treatment was advised except one plaster spica worn for a few weeks in 1914 and another worn for twelve weeks in 1915. A Wasserman taken early in the disease was negative, another taken a few months later was plus-minus and a third taken in 1918 was one plus. There was dental evidence of inherited syphilis in the deciduous teeth.

CASE 10. Boy aged 8. Symptoms which had existed for three months were so acute and limp so marked that first diagnosis was tuberculous hip. Plaster spica was ordered but its application was deferred to note the effect of medication. Potassium iodide up to twenty grains three times a day prescribed. In two weeks there was less pain and more freedom of motion. Four weeks later there was no pain, no spasm, very little limp. Hydrar, Chlor, Corr. Gr. 1-64 three times a day was added to the K. I. Three months after beginning of treatment the hip was apparently normal. Radiograph showed typical osteochondritis. Wasserman three plus.

Editorial

In order to reduce their disability to a minimum and to insure, as far as possible, their future independence, the government has wisely provided for our war cripples such a group of hospitals and such a scheme of hospital care and special training as has never before been seen or even dreamed of in this country. This situation in the military hospitals while most satisfactory, yet gives us food for serious thought in several ways.

We have, perhaps, twenty-five thousand war cripples. For the care of these, there is employed by the government, at the present time, approximately one medical officer for each fifty cases; one nurse for each twenty-five cases; one sergeant, corporal, or private in the medical corps for each twenty cases; one reconstruction aide for each fifty cases; and one instructor in the vocational schools for perhaps each fifty cases. This makes seven or eight individuals employed for the special care of each fifty of the war cripples. This does not include the officers and others engaged in the executive and administrative departments.

Now turn from this picture to another. We conclude that there is approximately one war cripple for each four thousand of our population, but we also know that we have in the United States in the neighborhood of three hundred and fifty thousand crippled children, one to each two hundred fifty or three hundred fifty of the population.

The experience of a number of institutions has shown that from sixty to eighty per cent of these children may be cured or greatly improved by proper hospital care, in other words, by modern orthopaedic surgical methods.

There is as yet no government interest in these cripples. A few states have provided special hospitals. A number of special hospitals have been provided by private philanthropists. There are, however, only a few thousand beds in all special hospitals of this kind in the United States.

These children patients are not only highly amenable to improvement by special surgery, but they can be greatly helped on

the way to independence by special training methods and special opportunities for education. Generally, their hospital care and special training should, as with the soldiers, go hand in hand. No one questions that the program of hospital care and special training for the soldiers wounded in the war was excellently conceived and splendidly executed. It is certainly a fact, however, that the neglect of civilian cripples is as unfortunate a thing as it has been to expose our boys to the crippling effects of the war. In the same way, relief for the crippled children is as imperative a duty as the effort to remedy war damage to the others.

British Orthopaedic Association

A special meeting of the British Orthopaedic Association was held at Liverpool on May 30th and 31st, 1919.

On May 30th the morning was devoted to a discussion upon "The Treatment of Flail Joints of the Upper Limb Following Gunshot Wounds," opened by Mr. Naughton Dunn (Birmingham) and Mr. Harry Platt (Manchester). This extremely difficult problem in war orthopaedics, produced a very active and interesting discussion. Professor Wood Jones explained the anatomy of two cases of snapping hip as demonstrated by operation and compared with the parts as found in normal dissections. Professor Wood Jones found that the snap was due to the existence of a strong deep tendon in the gluteus maximus, inserted low down, the patient being able to make this tendon snap across the great trochanter when the gluteus maximus was contracted. The snap was demonstrated on the operating table by faradising the glueteus maximus muscle. Mr. Rocyn Jones (London) showed skiagraphs of a case in which after reduction of a congenital dislocation of one hip, tuberculous disease developed in the other hip whilst the patient was fixed in plaster.

In the afternoon the following papers were read: "Two cases of unusual accidents to amputation stumps," by Mr. Muirhead Little (London).

"Some speculations on the functions of scar tissue," by Mr. D. McCrae Aitken (London).

"Observations on the treatment of static disabilities of the feet," by Mr. W. H. Trethowan (London).

"On the operative treatment of paralytic talipes calcaneo-cavovalgus," by Mr. Naughton Dunn (Birmingham).

In the evening the Association dined together at the Adelphi Hotel.

Saturday morning was spent at the Special Military Surgical Hospital, Alder Hey, where an interesting series of cases was shown by Major Armour and Capt. McMurray, and other members of the staff. The hospital wards, special treatment departments and workshops were open to visitors.

In the afternoon a visit was paid to the Liverpool Country Hospital for children at Heswell, which is beautifully situated overlooking the mouth of the Dee. Here after the open air wards had been inspected two operations were performed by Sir Robert Jones, transplantation of the peroneus longus and correction of a relapsed club foot, and one, reduction of congenital dislocation by Mr. Laming Evans. The Association then visited the children's country hospital at Leasowe, another open air institution overlooking the sea. This hospital is for 200 tuberculous children and is supported by the Corporation of the City of Liverpool.

Over fifty members and visitors attended the meeting.

Current Orthopaedic Literature

War Contractures—Localized Tetanus, Reflex Disorder, or Hysteria. By Lieut.-Col. Arthur F. Hurst, R. A. M. C. Seale Hayne Military Hospital.

The author's article covers 26 pages, has 32 excellent photos and 5 diagrams. He disagrees with Babinski and Froment in the second edition of their book published in 1917.

In the early stages the diagnosis between localized tetanus and hysterical spasm may be extremely difficult. If the contractures persist without abating for more than 3 or 4 weeks, and do not disappear completely at the end of 6 or 8 weeks, they are probably hysterical, even if they were at first due to tetanus. Spasms which begin immediately after the wound is inflicted cannot be due to tetanus; they are generally reflex and protective in nature, but are often maintained after the first few hours or days by auto-suggestion. A later onset is compatible with both tetanus and hysteria, and in both the extent of the contractures is often out of all proportion to the size of the wound. If the contracture persists in sleep, hysteria can be excluded. A general anaesthetic causes hysterical contractures to disappear more rapidly than tetanic contractures, which persist to some extent even under deep anaesthesia, although even the former may still be present after consciousness is lost. If the muscles are of a wooden and unvarying hardness, tetanus is almost certainly present. An increase in the size of the muscle, possibly due to obstruction of its lymphatics, without tenderness or subcutaneous oedema, is conclusive evidence in favor of local tetanus. The continued tonic contraction in tetanus is generally accompanied by spasmodic and more or less painful contractions, which are often brought on by external stimuli.

Froment and Babinski believe that many of the contractures which have hitherto been regarded as hysterical, or due to some obscure condition such as an ascending neuritis, as believed by Tinel, are really reflex in origin. They have summarized their views in the second section of their book published in 1917 on Hysterie-Pithiatisme et Troubles Nerveux d'Ordre Reflexe en Neurologie de Guerre. This theory at first seems to offer a satisfactory explanation of many cases, the nature of which had hitherto remained obscure; but a critical investigation of the subject has convinced us that such reflex conditions never occur.

There is no doubt that reflex contraction of the neighboring muscles is not uncommon immediately after a wound is inflicted, the reflex being protective in nature. When the symptom persists after the wound is healed, it is no longer due to any reflex action, but is the result of suggestion; the contracture is thus primarily reflex and subsequently hysterical.

If a hysterical condition is not diagnosed, they will receive long series of treatment for localized tetanus or reflex symptoms and will lose the value of psychotherapy.

The posture in hysterical contractures is identical with that which happened to exist at the time the contractures developed, and is in many cases that which was assumed immediately after the injury. Thus, if one or more peri-

pheral nerves were damaged, the position corresponds with what would result from paralysis, or occasionally from irritation, of these nerves. In such cases, when the nerve recovers from the effect of the injury, which may be within a few hours if the latter is nothing more than slight concussion, or may be weeks or months if it is more serious, the abnormal posture and the inability to move are maintained as a result of suggestion. In other cases the injury may lead to reflex spasm of the neighboring muscles and inhibition of movement of the whole limb which is protective in nature, but which rapidly disappears as the condition of the wound improves. The patient more or less subconsciously assumes the position which gives most relief to the pain. He does not realize that the absence of voluntary effort on his part had the object of saving him from pain, but believes that it was due to "paralysis"—the direct result of his injury.

Histories are presented illustrating all points raised by the author. Also the several positions of the joints assumed in hysteria.

In many cases the posture is that in which the surgeon fixed the limb by means of splints or bandages when it was first dressed. The patient becomes so accustomed to the immobility of the joint, that when the splint or bandage is removed, he fails to realize that there is nothing to prevent the return of the normal functional activity. He makes a feeble effort to bend the joint, finds that it gives rise to pain without any obvious movement resulting, and gives up the attempt in despair, reconciling himself to the notion that the joint has become fixed as a result of the operation and that no voluntary effort that he can make will have any effect upon it. A little manipulation, accompanied by a few words of explanation, could at this stage dispel the idea in five minutes, and months of disability would be saved.

The development of hysterical contracture and associated paralysis is due to the fact that the patient fails to realize that there is no reason why the spasm should not relax and the power of movement return when the primary factor—nerve injury, protective reflex, a conscious or subconscious antalgic spasm and inhibition of movement, localized tetanus, or fixation by splints or bandages—is no longer operative. The patient regards the contracture and inability to move as direct results of his injury, and naturally ignores the intermediate cause, such as the pain or tetanus. If it had been pointed out to him, when the pain was disappearing, that his incapacity was due to the pain and only indirectly to the injury, and that there was therefore no longer any reason why it should be maintained, he would have made the necessary effort and the hysterical condition would never have developed. Hysterical contractures and paralysis may result from injuries to the soft parts of the limb, with or without the bones and joints being involved. We have observed contractures and paralysis of exactly the same nature in the absence of actual wounds—as, for example, in fractures, dislocations, sprains and contusions.

The normal circulation thru a limb depends upon its active movements, the afferent nerve fibres from the muscles probably giving rise to localized reflex vaso-dilatation. If for any reason the arm is not moved in cold weather, the hand becomes shriveled, white or blue, numb, painful and stiff. These well-recognized changes disappear at once with active exercise and on warming the limb, both of which restore the circulation. The tendency to disturbances of this kind is much greater in people with a poor circulation than in those with a nat-

urally good circulation. It is thus natural for the immobility caused by paralysis or contracture of a limb, whether organic or hysterical, to result in deficient circulation and the same secondary changes.

When the venous and lymphatic stasis is very marked, and the paralysis absolutely complete, oedema may occur, especially if the paralysis is accompanied by contracture in a position in which the veins and lymphatics are obstructed by the rigid muscles. The deficient circulation results in changes in the physiological properties of the paralyzed muscles, even if the paralysis is entirely hysterical. When the hysterical contractions are cured circulation improves, and the parts gradually return to the normal. In breaking up hysterical joints one often tears the normal joint soft parts rather than adhesions and the resulting effusion is due to the tearing of the soft parts. Hysterical contractures only disappear after deep anaesthesia. Violent movements with incomplete anaesthesia may thus result in tearing contracted but otherwise normal muscle fibres as well as of normal fibrous tissue.

Anaesthesia due to cold if oft repeated may become hysterical in nature by auto-suggestion. This anaesthesia may be so complete that trophic ulcers may follow.

In hysterical contractures the x-rays show abnormal transparency of the bones, which is apparently due partly to deficient calcification and partly to absorption of the bony tissue, but we have never observed and definite alteration in their outline. Although the joints occasionally appear to be enlarged, the x-rays show no change in the articular surface: this corresponds with the fact that hysterical disorders of joints never give rise to any anatomical change as the result of pressure exerted on abnormal surfaces, however long the condition may persist. The enlargement of the joint may be due partly to oedema from deficient circulation, but is more often simply apparent, and due to the atrophy of the soft parts round the shafts of the bones. Lastly the nails become thin, brittle abnormally opaque and often show longitudinal grooves.

The excessive sweating which often occurs in these cases is less easy to explain. It may in part be a direct result of the cutaneous asphyxia when the circulation is unusually feeble. In cases of contracture in which the hand is tightly flexed, it is in part due to the air in contact with the palm being kept warmer than that in contact with the palm of the normal hand, and to the diminished evaporation which occurs in the enclosed space formed by the clenched hand. It is possible that the intense nerve impulses sent down from the brain to the centres in the spinal cord spread from the motor nerve-cells to the neighboring sympathetic nerve-cells which control the secretion of sweat. This would explain the fact that the sweating may occur, through to a less extent, in the normal hand.

When hysterical paralysis, with or without contracture, has persisted for some months and the psychotherapy leads to rapid recovery, it is often observed that, although the patient is able to perform every movement in a perfectly normal way at the end perhaps of an hour, he tends to maintain the abnormal posture, which was caused by the paralysis and contracture, directly his attention is withdrawn from the affected limb. Only if he constantly thinks of keeping his limb in the normal position, does the latter gradually become adopted even when no attention is given to it. Another striking fact about

these conditions is the maintenance of the abnormal posture of the arm or leg during sleep. Hysterical contractures disappear during sleep, but in spite of this the abnormal posture is maintained, so that it is only by actually manipulating the limb that the absence of the spasm of the affected muscles can be demonstrated.

The diagnosis of an hysterical contracture depends primarily upon the incompatibility of the symptoms with the injury. An injury to a nerve cannot account for persistent spasm of the muscles it supplies, and still less for that of other muscles; persistent muscular spasm resulting from injuries is thus invariably hysterical, unless the pyramidal tracts in the brain or spinal cord have been directly damaged.

If the posture is due to the perpetuation by suggestion of a position, which developed under the circumstances which uncontrollably placed the limb into a position the patient could not voluntarily assume, its maintenance for a more or less prolonged period before the responsible circumstances cease to be operative would be sufficient to train the muscles involved to continue to act in the same way, and would also lead to the development of postural length of the muscles, which would help to keep the part in the abnormal position, even after psychotherapy had resulted in a cure of the contracture and paralysis.

Treatment begins with a full explanation of the cause of the symptoms in language suited to the patient's intelligence and degree of education, followed by persuasion and re-education, combined in most cases with manipulation, which doubtless acts to some extent by suggestion. A very important, but by no means essential, preliminary is the creation of a proper atmosphere of cure. The patient is made to understand that any treatment he has already received has prepared the way, so that nothing now remains but a properly directed effort on his part, with our help, for complete recovery to take place. During the whole course of treatment he is engaged in conversation, and the meaning of each successive step is carefully explained. He is made to watch the contraction of the muscles and play of the tendons of the normal limb, and to attempt to imitate them in the affected one. In some cases it is not even necessary to touch the patient, mere explanation and persuasion being sufficient to cause him to relax any spasm which may be present, and then to perform the various movements of the part with quickly increasing strength and rapidity.

When very great difficulty is experienced in getting the contracted muscles to relax, the limb should be placed in very hot water, and the manipulations carried out when the circulation has been artificially improved in this way. Some relaxation always occurs because the rigidity is in part the direct result of the deficient blood supply. Passive movements are most effective if carried out by the medical officer himself, as the patient is engaged in conversation the whole time and made to take an active part in the movements from a very early stage in the first sitting. For this reason we never employ the mechanical appliances for performing passive movements, which have been boomed to such an extent during the last few years.

The paper is an excellent summary on hysteria.—*Leo. C. Donnelly, Detroit.*

TREATMENT OF PURULENT ARTHRITIS BY WIDE ARTHROTOMY FOLLOWED BY IMMEDIATE ACTIVE MOBILIZATION. By Dr. C. Willems, Ghent, Belgium.

No therapeutic law has been more firmly established than that which has made immobilization obligatory for every joint injury, from the mild to the most severe. Nevertheless we all know its consequences; muscular atrophy which is rapid for certain muscles such as the femoral quadriceps, and stiff ness of the joint. Also we know that such complications when once established are extremely tenacious and that frequently they do not yield completely to varied and very prolonged physiotherapeutic treatment. Even in the more fortunate cases it is necessary to continue such treatment for some months before getting the required results. Immobilization has been considered a necessary evil.

I have freed myself by degrees from practicing the law of immobilization. I commenced evacuatory punctures to drain traumatic effusions of the knee, hemarthroses and hydarthroses, and by making the patient walk immediately. Not only could they do this without any difficulty but their lesions cured in a few days without leaving any trace.

Since the war the great frequency and infinite variety of articular lesions gave me the opportunity of applying this new method on a large scale. In the simplest and most severe conditions I have used immediate active mobilization after the operations for penetrating joint wounds with or without an included projectile and for all varieties of intra-articular war fractures. I have not confined myself to non-infected fresh cases. I have also treated cases of purulent arthritis and it is perhaps in these difficult infected cases that the method has given the most astonishing success. But the object pursued differs. In simple lesions immediate active mobilization obviates atrophy and ankylosis. In purulent arthritis it seeks on the contrary to drain the articulations. In the first case the joint must be completely closed; in the second it must be left widely open.

A word as to the technique. It is practically the same whether the wound is aseptic or infected. In the case of recent injuries we commence by excising the soft parts of the wound, proceeding with the eventual esquillectomy of the fracture area, extracting projectiles and hermetically closing the joint. In purulent arthritis on the contrary; we must first execute an arthrotomy and leave the wound largely open. But starting from this movement we always proceed in the same way for mobilization.

The expression "immediate active mobilization" must be taken in its literal sense. The mobilization must be active, that is to say, made by the patient himself by muscular contractions. The movements ought to reproduce the essential normal movements. Extension, flexion and rotation. The goal to be reached is to restore the physiological function of the articulation as much as possible, and in the case of the knee this function is walking.

Active mobilization cannot in any way be replaced by a passive mobilization which does not call into play either the muscles of the limb or its nutrition and which tends to restore mobility alone.

Mobilization must be immediate, that is, commenced as soon as the patient awakens from the anaesthesia. The patient must not be permitted to rest. The

movement must be pushed to the maximum in every direction and must be kept up, so to speak uninterruptedly. He needs supervision by a personnel in touch with the necessities of the treatment.

Active mobilization is not painful in the true sense of the term, except according to the extent of the lesions, the courage of the patient and his aptitude in directing his efforts to the muscles which must be contracted and not wasting his strength in contracting other muscles than those necessary, movements become easy according as they are repeated.

Active mobilization is not painful in the true sense of the term, except when it displaces large bone fragments and in such a case it is contra-indicated. But the movements are laborious and call for effort. It is found that a patient treated by active mobilization uses his limb in a variety of non-prescribed ways which he would not employ if the movements were painful. Many have stated that when a little pain is felt in periods of rest the best way of stopping it is to resume the movements.

Active mobilization gives the most surprising results in purulent arthritis. I do not hesitate to assert that against this formidable infection the new method is more efficacious than any of the means hitherto at our disposal.

In applying mobilization to the treatment of articular suppurations, my chief aim was to realize a satisfactory drainage after arthrotomy. We know that efficacious drainage of a joint by the ordinary means is a Utopia. No kind of tube, no system of tampons, no means of irrigation, obviates retention nor stops the progress of infection. And it is on account of this insufficiency of drainage that arthrotomy has been almost abandoned and replaced by resection. But I have always been under the impression that to resect for the purpose of drainage alone is to go too far; and I have endeavored to empty the joint by expression, thanks to active movements. When a suppurated articulation has been opened by a large uni- or bilateral arthrotomy (a uarthrotomy is never necessary) this is what is observed: At each extension and at each flexion the synovial surfaces are forced together by muscular contraction and pus is expressed often in the form of a jet. When the movements are very extensive and the muscles contract more vigorously the expression of pus is so much the more complete. If the movements are repeated a sufficient number of times the secretions are eliminated in accordance with the movements, retention is prevented and articular drainage profoundly influences the local and general conditions. Locally, suppuration evolves like an ordinary abcess, but slowly. It lasts for a few weeks abundant at first, then less and finally disappears completely. During this period, the arthrotomy opening or openings cicatrize. A species of fistula persists which closes from time to time and must be periodically opened. Oedema of the periarticular tissues diminishes very rapidly and the tissues remain supple. Peri-articular abcesses are, so to speak, unknown.

With regard to the general state it is rapidly modified. From the commencement of active mobilization fever falls, not completely, as the patient may show 38 degrees C. for some time. But the feverish aspect disappears; such patients do not look like badly infected cases.

Drainage is therefore realized in an ideal manner without a tube, and without irrigation of any kind. I am of the opinion that irrigations are more harmful than useful.

Drainage was my aim at first but I obtained more. I have obtained preservation of the articular mobility. Unquestionably we must consider the recovery of a purulent arthritis with ankylosis as satisfactory, and be thankful that the patient has escaped resection, but it is evident that a mobile joint is much better than the best kind of ankylosis.

If the procedure is followed in the manner indicated, mobility of the joint will always be preserved. From the moment suppuration notably diminishes we sometimes see a tendency to stiffness. This is why I now partially and progressively close the arthrotomy wounds from this moment, and only leave such openings that are strictly necessary for the discharge of pus which is still forming. Proceeding in this way, mobility will be perfect and absolutely normal in the great majority of cases, no matter what the causative microbe may be. The limb will show no functional disturbance after an infection as terrible as purulent arthritis was formerly considered.

In purulent arthritis still more than in non-infected lesions it is difficult to realize the possibilities of active mobilization. It is so contrary to classical ideas that we must see the patients move their limbs in order to understand. The truth is that movements are perfectly possible in purulent arthritis treated by arthrotomy, to the same extent as in non-infected articular lesions treated by incision of the damaged tissues and total primary suture. Movements are no more painful in the first place than in the second. They are equally laborious in the two cases. True pain appears only when the drainage is insufficient; and when it becomes necessary to drain more completely to cause an immediate cessation of pain. Whenever a patient complains of pain, especially in the politeal space, it is almost certain that there is retention. The patients themselves soon learn to recognize this cause of pain and stop it by means of some movements.

Patients with purulent arthritis of the knee can walk early, even before cicatrization of the arthrotomy wound. It is the same with purulent tibiotarsal arthritis. It is a curious experience to see them walk with the joint widely open, expelling a little pus at each step.

With regard to the question whether immediate active mobilization is applicable to cases in which purulent arthritis accompanies an intra-articular fracture, it can be answered affirmatively. As in non-infected lesions mobilization can be effected in purulent arthritis with fracture on condition that there is no fear of displacing the fragments. If there is, movements are contra indicated because they might dislocate the joint.

A second circumstance which renders this method inapplicable is primary destruction of the ligaments and of the articular capsule. When the means of union have disappeared it is evident that the joint can no longer be mobilized by muscular contraction. But it is well to know that a partial destruction of the means of union does not render the treatment quite inapplicable.—*Leo. C. Donnelly, Detroit.*

THE "NO SPLINT" TREATMENT OF FRACTURES ABOUT THE SHOULDERS, IN THE HUMERUS AND THE ELBOW. Dowden, J. W. *Edinb. M. J.* 1918 XXI, 328.

Dowden claims that as a result of his "no splint" treatment of fractures about the shoulder, in the humerus and the elbow, it is possible for a patient to return to work in six or eight weeks, regardless of the nature of his occupation.

His treatment of fractures is mainly without splints, unless application is found absolutely necessary. For ten years he has been treating fractures in these regions without splints and has never been disappointed, nor has he ever had a case of non-union or a single bad result.

The patient is encouraged to use his fingers and do what he can with them, carefully to pronate and supinate, flex and extend the forearm, and gently try to move his shoulder-joint and arm, but never to the extent of producing pain.

He has endeavored to apply the same principles to the leg as to the upper extremity, but as yet has not been able to perfect a method.—*Leo C. Donnelly, Detroit.*

THE TREATMENT OF THIGH FRACTURES WITH A MODIFIED THOMAS SPLINT. Hardouin: (Note sur le traitment des fractures de cuisse par l'appareil de Thomas modifié) Bull. et mim. Soc. de chir. de Par., 1918.

Fixed in the ordinary way as for transportation the author got bad results with the Thomas splint, the patient complaining of ischiatic pressure, and the apparatus slipping above the ischium in any movement of the patient, which annulled the action of the apparatus. To prevent this, the author placed a plaster jacket around the pelvis and the upper part of the thigh over the seat of fracture. When the plaster was dry, contra-extension was applied and the Thomas splint then applied in the usual way, being fixed high and solidly on the plaster cast by strong bandages or other means.—*Leo C. Donnelly, Detroit.*

GUNSHOT WOUNDS OF THE SPONGY BONE TISSUE. De Gaulejac, H., and Nathan, M. (Les lésions de l'os spongieux par projectiles de guerre.) Rev. de chir., 1918, IV, 341.

The author calls attention to the gravity of these lesions and states that they are frequently overlooked.

These damages can only be observed after wide excision and the turning back of the periosteum. This is necessary in the treatment of all penetrating projectile wounds. Examination shows that a projectile causes disruption of the osseous tissues as in the soft parts. The fragile structure of the spongy tissue explains the extent and gravity of these lesions, which soon give rise to haematomata. These injuries are contusions in the same sense as those of the soft parts. They differ only in the primarily massive character of the necrobiotic lesions which form favorable culture media for microbes.

In this type of lesion, important both because of its extent and primary septicity, there is very often a long period of latency.

The prognosis is grave. Apart from local manifestations, of which arthritis is the commonest, there are general complications which may become chronic. As regards surgical treatment, experience has shown that periosteal decortication and wide excision of tissues is the only way to ensure healthy primary reunion.—*Leo C. Donnelly, Detroit.*

Kobler's Disease of the Tarsal Scaphoid in Children. Frederick W. O'Brien. *Boston Medical and Surgical Journal*, April 17, 1919.

The cases in the literature are taken up, and one is reported with X-ray examination.

The various suggested causes are taken up, viz: traumatic osteitis, fracture of the ossification center. The X-ray findings are typical. The scaphoid is smaller, form regular, architecture impossible to recognize, and density increased. The trouble disappears under indifferent treatment.—*Edward S. Hatch, M. D., New Orleans, La.*

Treatment of Cases of Fractured Femur at a Base Hospital in France. *British Journal of Surgery*, January, 1919. Lieut. Colonel Victor Hurley and Maj. S. H. Weedon.

The author's report on the methods and conclusions drawn from 170 cases of fracture of the femur treated in a Base Hospital during a six month period from July to December, 1917. All cases were treated until firm union had occurred and various methods were used. The Thomas knee splints were used with such modifications as were deemed necessary.

Patients arrived in the hospital within 36 hours to 7 days from time of injury; most of the cases being admitted on the third and fourth days, having had preliminary treatment at the casualty clearing stations, where they usually received the Thomas splint. The wounds had been excised with a varying degree of thoroughness. The authors believe that ordinary soap and water or saline give as good result in the after care of the wounds as the antiseptic lotions and pastes. The cases which did the best were those in which the wounds were thoroughly excised and adequate drainage had been provided. There was a mortality of 38 per cent within 48 hours after admission. Portable X-ray apparatus was used which allowed the patient to remain undisturbed and which is essential to obtain the best results. The indications for general anaesthesia are given.

Since in war surgery, patients are passed on from surgeon to surgeon the indications for further operation are given as (1) spreading sepsis or gas infection in incompletely drained wounds; (2) insufficient removal of bone fragments; (3) Vascular gangrene of the limb.

The splint selected must be determined by; (1) the position and extent of the wounds in the soft parts; (2) the site of fracture. The Thomas knee-splint was found most serviceable except in those cases with extensive wounds of the

buttocks and posterior aspect of the thighs, in which a Hodgen splint was used. In some cases where the wounds of the buttocks and pelvis were so extensive that no splinting was possible, a Sinclair net bed or Bryan's bed was used. In fractures of the head, neck, or upper third of the femur a double Thomas knee splint was used. In those below this level a single Thomas splint was used. Extension is obtained by the use of a bandage or Sinclair's glue or a caliper extension device by Major M. Sinclair. The authors describe their method of application of splints and have splendidly illustrated the article. Regular massage is carried out and the motion of the hip joint is encouraged as soon as firm union has been established. From the commencement the patient is instructed to perform each day a certain number of movements of his feet and toes which is readily permitted on a foot piece which is used.

Sepsis, secondary hæmorrhage, arthritis, associated nerve injuries and foreign bodies are taken up.

The length of time necessary to obtain firm union is determined; (1) by the extent of the original loss of bone; (2) the degree of subsequent sepsis; (3) accurate reduction of deformity and (4) complete division of the sciatic nerve.

The proportion of cases in which non-union occurs was probably not greater than 1 per cent.—*H. W. Meyerding, M. D., Rochester, Minn.*

Early Treatment of Compound Fractures and Other Severe Injuries of Upper Limb.—F. G. Slessinger, *Lancet*, March 8, 1919.

Primary Suture—Injuries Without Fracture

The whole injured tract is excised en bloc, try to restore the functional anatomy of the limb, and suture nerves in all possible cases, this helps even though the wound is septic. Both severed vein and artery should be tied. Heat for the parts is useful in primary suturing.

Wounds Complicated With Fractures.

Completely loose bone fragments should be removed, fractures of the lower end of the shaft of the humerous are often best put up in extreme flexion. If there is any paralysis of the musculo spiral group of muscles the nerve should be repaired at once. The middle third of the radius is hard to hold in position, as are of course fractures of both bones of the forearm. Extreme supination should be kept up. A tennis ball placed in the palm helps.

In joint wounds a thorough, immediate cleansing and closure give the best results.

When the head of the humerous or radius is badly shattered incision is best done at once.

In infected wounds removal of dead tissue and the use of Dakin Solution for its hydrolytic action is advocated.

Edward S. Hatch, M. D., *New Orleans, La.*

DISEASES OF THE BONES, JOINTS, MUSCLES, TENDONS, CONDITIONS COMMONLY FOUND IN THE EXTREMITIES. De Gaulejac and Nathan. Pathologic Study of Bone Substance. (Etude pathologique des pertes de substance osseuse) Bull. et mem. Soc. de chir. de par., 1918, xliv, 1918. Vol XXVIII, June, 1919. No. 6. *Sur. Gyn. and Obst.*

The conclusions reached by the authors are as follows:

1. Periosteum owes its osteogenetic properties only to the bone particles which adhere to its deep face. This faculty is common to it and other kinds of connective tissue.

2. Ossification takes place in the interior of a Haversian canal the lumen of which is progressively diminished and obstructed.

3. Ossification may take place also by diffuse proliferation of the osteoblasts which progressively invade the neighboring connective tissues.

4. Ossification may be effected directly without the mediation of osteoblasts by the simple transformation of collagen into pre-osseous substance. In such case, as Nageotte has observed, the fibroblast takes on the character of an osteoblast only after complete transformation of the collagen.

The clinical deductions from this part of the study are:

1. The presence of a haematoma is an obstacle to bone regeneration.

2. The larger the surface of bone in contact with the neighboring connective tissues the better.

3. Bone repair may be effected at the expense of fibrous tissue, the collagen of which is transformed into pre-osseous tissue under the influence of its surroundings.

In regard to the reaction of the compact bone, the authors reach the following conclusions:

1. Compact bone has one fertile bed, i. e., the middle bed, that of the Haversian canals. This osseous bed reacts to all traumatic or inflammatory causes by a more or less complete return to the condition of indifference.

2. The reaction, which can be seen radiographically, shows enlargement and multiplication of the Haversian canals and diminution of the standing affinity of the bone substance.

3. When the external limiting layer of bone surface is destroyed, the middle bed, if uninjured or injured only slightly, is capable of proliferating into the neighboring connective tissue. Hyperostosis becomes exostosis.

4. These anatomic processes may be produced experimentally.

5. The repair of compact bone tissue by means of connective tissue is worthy of a place in practical surgery.

6. The external limiting bone layer is an arresting layer interposed between the middle bone bed and the neighboring connective tissue.—*Leo C. Donnelly, Detroit.*

CENTRAL LUXATION OF THE FEMUR OR PELVIC ERUPTION OF THE HEAD OF THE FEMUR. Froelich. (Luxation central du fémur, ou mi ux, irruption pelvienne dé la tete fémorale) Rev. d'orthop., Par., 1918, vi 303. Vol. XXVII, June, 1919. No. 6. *Surg. Gyn. and Obst.*

The study of the pathological anatomy shows two of three types of such fractures: Class 1, fractures limited to the bottom of the acetabular cavity without notable fissuring; Class 2, fractures of the bottom of the cavity with fissures radiating to a distance. Class 2 has two types. In one, the femoral head has detached the anterosuperior segment of the cavity and become embedded in the pelvis. The second type of irradiating begins, like the first, by a fissure between the anteroinferior iliac spine and the pectinate eminence but is distinguished from the first by the fact that the superior-anterior segment is involved while in the first type mentioned there is involvement of the inferior-posterior fragment. It is these two types which are the most frequently observed. The obturator nerve is often torn or contused and the vessels in the vicinity, including the iliac vein, may be injured. A fatal hæmorrhage often results. In addition to the nerve and vascular lesions there may be also extensive damage to the pelvic viscera.

The main points in the symptomatology are absolute funtional impotence, flattening of the trochanteric region, external rotation of the lower limb and a slight ascension of the great trochanter above Bryan's line. The distance between the great trochanter and the symphysis pubis is diminished. Concomitant lesions may give rise to special symtoms. The signs of pelvic eruption of the femoral head are shown by radiography and fix the diagnosis.

Treatment consisting in the reduction of the displaced femoral head under chloroform ought to be instituted as early as possible. Different operators use different modes of traction in effecting the reduction.

If reduction cannot be obtained by manipulation, recourse must be had to operation. Froelich believes that the best incision is that which is used for ligature of the external iliac artery as it gives direct access to the bottom of the cotyloid cavity. Traction to maintain the reduction will be necessary for from six weeks to two months. Orthopædic measures for the complications should be used as required.—*Leo C. Donnelly, Detroit.*

NOTES ON GUNSHOT FRACTURES OF THE FEMUR. Massie, R., and Swanson, G. C. *J. Roy. Army M. Corps, Lond.*, 1919, xxxii, 24 Vol. XXVII, June, 1919. No. 6. *Surg. Gyn. and Obst.*

Fractures caused by long range, high velocity bullets are less serious than those caused by ragged projectiles or low velocity bullets. The latter are more common. The highly comminuted fracture is the most frequent type.

In fractures of the upper, middle and lower thirds alike, it has been found best to follow the general idea of extension.

The extending force must be in the direction of the long axis of the upper fragment, with the lower fragment aligned with it.

The medium ring Thomas splint is most useful, except in cases of high buttock or perineal wounds.

A superior method of extension is the application of calipers to the condyles of the femur, except when there are wounds of the lower third of the thigh, in which case there is difficulty in maintaining asepsis.

The caliper points should be introduced through a small puncture wound to obtain a water-tight junction; they should not be sharp and should penetrate the bone not more than 1-16 inch. If uninfected, they may be left in situ for six to ten weeks.

In cases not amenable to extension, internal fixation may be applied by wiring by encirclement, or, in cases of transverse fracture, by wiring a Lane's plate to the opposing ends of the fracture.

Chief among the complications are: (1) Involvement of the knee joint; (2) involvement of the sciatic nerve; (3) gas gangrene; (4) secondary hæmorrhage; (5) comminution, and (6) spreading sepsis.

Spinal anaesthesia or gas and oxygen are the anaesthetics of choice when amputation is necessary. The fall in blood pressure observed during the first ten minutes following spinal anaesthesia is best counteracted by the injection of intravenous saline or citrated blood.

In the treatment of wounds, dependent drainage is preferred to the Carrel-Dakin system.—*Leo C. Donnelly, Detroit.*

Present Treatment of Flat Feet. S. B. Burk. *U. S. Naval Medical Bulletin*, January, 1919.

Causes of flat feet are constitutional and local.

Predisposing or constitutional causes are shortened tendo achilles, inflammations, traumatisms, etc.

Local causes are knock knees, poorly fitting shoes and other conditions which produce toeing out.

Various exercises are advised for flexible cases, and the operative treatment of the rigid type is spoken of.

Edward S. Hatch, M. D., *New Orleans, La.*

Fractures of the Upper End of the Humerus. Stevens, J. H. Ann. Surg., Phila., 1919, lxix, 147. Vol. XXVIII, June, 1919. No. 6. *Surg. Gyn and Obst.*

The author classifies fractures of the upper end of the humerus as follows:

Type 1: Fracture of the greater tuberosity without displacement. Subdivision A: With displacement. Both types may be complicated by subcoracoid dislocations. The shaft and neck are both intact.

Type 2: Fracture of the neck of the humerus without displacement. Subdivision A: With displacement of fragments, the head remaining in the glenoid.

Subdivision B: Displacement of the head from its relation to the shaft. The head is also dislocated out of the glenoid.

Type 3: Fracture of the neck of the humerus with complicating fracture of the shaft of the bone.

Regarding the treatment, the following conclusions are drawn:

1. Fractures of the upper end of the humerus, i. e., above the insertion of the pectoralis major muscle, will in nearly all cases conform to the three types given and three subdivisions. All should be treated in abduction and external rotation, with traction varying from a few days in mild cases to twelve days in complicated cases.

2. Passive motion must be begun early and followed very quickly by active motion to prevent the tendency to restriction of motion. Care should always be used and due regard taken of anatomy and pathology. In the mild cases it is safe to begin motion very early since there is little tendency toward displacement.

3. A right-angled wooden splint in severe cases, and a firm pillow splint in mild cases, with traction, is the ideal method of treatment.

4. External rotation in abduction as a treatment is almost impossible unless the patient remains in bed when it is the simplest method and not uncomfortable.—*Leo C. Donnelly, Detroit.*

The Historical Development of Public Provision for the Disabled Soldier. McMurtrie, D. C. Interst. M. J., 1919, xxvi, 109. Vol. XXVII, June, 1919. No. 6. *Surg. Gyn. and Obst.*

France was the first European country to establish a home for disabled soldiers. The Hotel des Invalides, established by Louis XIV, was supported by taxation, two, and later three, deniers being levied on every livre spent by the government for military purposes. In the twenty-eight years between 1679 and 1704, 15,000 soldiers applied to this institution for admission. Sisters of Charity cared for the sick. Instruction in a trade, with the necessary tools, was provided by the administration for those interested.

To married inmates permission was granted to visit their families, such permission gradually developing into 3-year leaves on an allowance of not less than 100 livres. Soon the 3-year leaves were extended indefinitely, the allowance automatically becoming pensions, with the result that in 1790, in addition to the 2,370 disabled men in the Hotel, pensions were paid to 26,000 soldiers. Thus in France, the two principles of institutionalism and pensions—principles ultimately adopted by all the western nations—came to exist side by side, and, revised and regulated, were operative when the war of 1914 began.

In England the first steps for the relief of soldiers were taken by Queen Elizabeth for those invalided home from Flanders. During the time of the Commonwealth, Parliament provided for pension grants, hospitals and homes for soldiers, who had been disabled fighting for Cromwell.

In 1682 the Royal Hospital at Chelsea for disabled soldiers which was to

be supported by money compulsorily deducted from the soldiers' pay, was begun. The same year saw the beginning of the Greenwich Hospital for disabled seamen. Both institutions were completed under the rule of William and Mary.

Early in the nineteenth century Parliament passed an act granting pensions to all soldiers who were invalided, disabled or discharged after from fourteen to twenty-one years of service. At the close of the South African war, this system of relief was extended to include widows and orphans of those who died in the service.

No nation hitherto has been so generous in its provision for disabled soldiers as the United States. Plymouth Colony passed its first pension legislation in 1636, other colonies soon taking similar measures. A few months after the beginning of the Revolution, the Continental Congress declared that half pay would be granted every officer, soldier and sailor incapacitated during the war.

In 1792 the first general pension law was enacted, providing for the payment of $5, and later $8, to all privates and non-commissioned officers. This system of relief, with slight revision, continued down to the Civil War. During the Civil War, the principle of fixed rates for specific disabilities was introduced.

In the United States there are now more than 30 soldiers' homes supported by the several states. In some of these the wives, mothers, widows, sisters and daughters of the beneficiaries are also maintained. The inmates of these homes number about 11,000. There are also two Federal institutions caring for between 18,000 and 30,000 men.—*Leo C. Donnelly, Detroit.*

Experience Gained From 250 Operations on Peripheral Nerves. A Blencke. Zeitschr. f. orthop. Chir. Vol. 38. 1.2, 1918.

The material covers 250 cases with involvement of a total of 311 nerves.

In 4% of the cases there were direct lesions of the nerves which excluded by their intensity any chance of spontaneous restitution. The resection of the nerve was necessary in 161 cases out of 311 that is in more than half of the cases demonstrating the necessity of operative procedure. Bier found a clear severance of the nerves in one-fourth of his operative cases.

The author concurs with Steinthal's indications for operation which are shortly as follows:

1. Motor paralysis with total reaction of degeneration.
2. Partial motor paralysis with total, not improving, reaction of degeneration.
3. Pareses which are growing worse.
4. Grave neuritic symptoms.

Absolute contra-indications are:

1. Suppuration.
2. Pareses which improve.
3. Extensive scar formation.
4. Severe muscle degeneration.
5. Partial paralyses with little functional disturbance.

Of 209 cases with involvement of a single nerve the incidence was as follows:

Musculo spiral involved 97 times.
Sciatic involved 56 times.
Ulnaris involved 31 times.
Median involved 24 times.
Crural involved 1 time.

The musculo spiral was most often injured at its spiral turn and around the humerus. The sciatic shows isolated lesions of the peroneus externus 19 times.

The Ulnar was most often involved at the forearm (19 times), the median at the upper arm (14 times).

Regarding sensory disturbances the injuries to the musculo spiral showed the least symptoms of this kind.

Injuries of the median nerve and of the sciatic showed very frequently trophic disturbances and neuralgic symptoms, the latter most intense in injuries of the sciatic nerve.

Of considerable interest are the author's operative findings. He distinguishes three groups of cases.

In the first group the nerve is entirely intact and there are only mechanical obstacles in the shape of scar tissue of the soft parts and changes of bone which kink or constrict the nerve and in this way constitute an obstacle to the motor conduit. In these cases there were found all degrees from partial paralyses to complete paralyses with complete reaction of degeneration in spite of the fact that the nerve itself was found intact. Very fine strands of scar tissue of the thickness of a silk thread up to extensive films of adhesions, were found as causes of constriction.

In the second group of cases, there was likewise no break in the continuity of the nerve but the scar tissue was not only found surrounding the nerve but was infiltrating the nerve itself, involving the perineural sheaths as well as the endoneural tissue. These perineural scar formations which by constriction interrupt nerve conduction often exceed by long distances the wound canal. For the formation of the endoneural scar tissue the rupture of blood or the lymphatic vessels or inflammatory reactions within the nerves themselves are held responsible.

The third group constitutes the cases of actual, partial or total break in the continuity of the nerve, caused by the projectile or splinters of bone. The nerve in these cases shows the well known changes of neurmma and glimona formations.

The author described at length the technique of nerve suture with a complete enumeration of the instruments to be used.

Post-operative adhesions are best prevented by the use of hardened calf arteries applied as sheaths covering the places of nerve suture. The author had no especially favorable results from the use of Galalith, a case in preparation made pliable by soaking in hot water. Neither does he recommend the use of fascia because of the subsequent shrinking of the latter with constriction of the nerve. Pedicled muscle flap also gives rise to constricting scar tissue if

used as envelopment for the sutured nerve. The use of hardened calf arteries, however, has in the hands of the author always given satisfactory results.

Hardly any exception can be taken to the author's viewpoint that the postulate of Stoffel that corresponding nerve bundles should be brought into exact contact in end to end suturing of nerves is an Utopian idea, impossible of accomplishment in actual practice.

Gaps of the nerve are best handled by proper flexion position of the joints which allow of proper approximation of the ends without tension.

Bridging of nerve defects by nerve flaps and by the pruning method of Hofmeister was carried out in a number of cases but no definite results are reported (nor are they at all likely ever to occur).

In regard to definite results no personal data are given by the author. However, he quotes Guleke, who found good results in twelve cases among twenty-one cases of neurolysis or over 60%, and twenty-six good results or 42% in 62 cases of nerve sutures. Oberdorfer had 72 good results or 22% in 340 cases of nerve sutures. The author had 31% cases of full results in 46 cases of neurolysis but does not give any statistics as to his cases of nerve suture.

He concludes with the somewhat conservative statement that while a number of cases of nerve sutures will show very perfect results and another number remarkable improvement, a vast number of cases will remain unimproved after the end to end suture in which ultimately tendon operations or other methods will have to be applied.—*Arthur Steindler, Iowa City, Iowa.*

The Treatment of Functional Disability of the Limbs in a Special Military Surgical Hospital. By Lieut. Wm. Cuthbert Morton, C. B. E., R. A. M. C. Officer in Charge of the Re-education Department of the 2nd Northern General Hospital, Leeds. Vol. VI, April, 1919, No. 24, *The British Journal of Surgery.*

The author fully reports 44 cases, with photographs, of functional disability. Each patient is examined for the first time privately and no one is ever treated in such a way as to lead him to think that his disability is not regarded as a very real thing. It is quite possible to conduct the examination without giving rise to any unfortunate "suggestion."

The patient explains what he cannot do, and is then asked about anything previous or subsequent to the disability which may have any bearing on the case. The limb is examined for oedema, scars, deformities, abnormal postures, involuntary movements, and the like. The movements which the patient cannot voluntarily execute in a perfectly normal manner are noted. The whole limb should be examined in every case, since in drop-foot, for example, the leg and thigh may also be involved so that weakness of abduction at the hip-joint may have caused the pelvis to drop on the other side.

The muscles not functioning properly are noted, with special reference to their condition both when the patient is at rest and also when he is attempting voluntary movement.

It is impossible to believe that every functional disability has been brought on by suggestion; and the man who persists in a functional disability initiated by organic mischief may be no more of a hysteric or a malingerer than the man who remains deaf for some time in the belief that he is incurable, although, when he is at last persuaded to have medical advice, he recovers his hearing completely as soon as the ears are syringed; it was a mistake, stupid perhaps, but no more.

The first problem is diagnosis. How much of the trouble is organic? Is there, or has there ever been, any direct damage to the muscles themselves, to the bones upon which they are designed to act, or to the upper or lower motor neurons by which they should be controlled? Or is it that the tone of the whole muscular system has been so lowered that those muscles which in the course of evolution have been subjected to the greatest strain (as, for example, the peronei, or the abductors of the hip, or the deltoid) can no longer "carry on"? Or is there indirect organic trouble? Is there a reflex (painful or simply protective) causing spasm, or is oedema hampering the muscles (partly by faulty nutrition and removal of by-products, partly by thickening and stiffening of the limb and of the muscles themselves)? Or have the muscles been so long out of action that their sensory mechanism is out of gear? Is there any alteration in the equilibrium of the body, such as a short limb causing pelvic drop and scoliosis, or on the other hand an injury causing scoliosis followed by pelvic uptilt and an apparent shortening of the limb? Is there a loss of the normal muscular antagonism, through a direct injury of the antagonists or their nerves?

In every case a plain statement of the facts and difficulties is made to the patient. If any part of the disability is incurable, he is frankly told so. The rest of the trouble is explained as being due to muscle habit and curable; and as far as possible some period is fixed within which he should be quite cured, whether it be one lesson, one day, one week or one or more months, due emphasis being laid on the fact that, as in full physical training, a great deal depends upon his own efforts. Although the method of treatment may vary according to the nature and site of the disability, yet they are all based upon the same principles—namely, stimulating the muscular sense, restoring the reciprocal action of antagonists, and co-ordinating all the muscles under the unerring control of an educated central nervous system. Each muscle must be taught to function properly, to contract and relax at will, and so, by acting at the proper moment with the proper degree of force, to secure complete co-ordination of all the muscles of the part.—*Leo. Donnelly, Detroit.*

The Diagnosis and Treatment of Injuries to the Crucial Ligaments. Smith, S. A. *Brit. J. Surg.*, 1918, VI, 176.

The general treatment of injuries of the crucial ligament should be conservative rather than operative. When the injuries are of long standing operative measures are indicated.

The author's technique is described in detail. He makes a J-shaped incision as for excision of the knee. The patella is divided vertically, and the crucial ligaments exposed and examined. A hole is bored by a one-fourth inch drill

through the internal surface of the external condyle at the site of the upper attachment of the anterior crucial ligament, and emerges at the upper level of the suprapatellar pouch. The internal tuberosity of the tibia is next drilled beginning anterior to the insertion of the sartorius and emerging on the superior articular surface of the tibia just anterior to the internal tubercle of the tibial spine. A strip of fascia lata one and one-half inches wide is now cut, attached at its bottom and about nine to ten inches in length. A flexible probe is pushed through the tibial drill hole and passed through the femur and pulls the fascial strip with it. As much tension as is thought fit is applied to the new ligament and the tibia is forced backward on the femur as much as possible. The free end of the fascial strip is passed through a channel cut for it in the inner condyle, pulled tight and is sutured to the periosteum around the opening in the tibia. The fascia curls as it passes through the bone and makes a ligament about the size of a pencil. The operation is then completed and the wound drained. The limb is kept in a skeleton splint for two weeks, in flexion.

THE TREATMENT OF LITTLE'S DISEASE. Ernset Gasne. *Revue D'Orthopedie*, August, 1918.

The author gives a very thorough synopsis of the different methods in use.

In regard to symptomatology the cerebral and spinal forms must be distinguished. The spinal symptoms consist in paralytic contractures but with decided predominence of the contracture over the paralysis. More often these contractures are generalized or at least very extensive, at the time of birth. But the contractures diminish gradually, releasing first the muscles of the face, neck and trunk. Then come the muscles of the upper extremity so that often, in time, the paralysis becomes limited to the lower extremity, as though the pyramidal tract in its process of regeneration were restoring the short nerve bundles of the upper but not reaching longer bundles for the lower extremities.

In contrast to this, in the cerebral form, there exists aggravation rather than diminution of the symptoms. Under the influence of treatment, however, there are remissions in this type also.

In the majority of cases, therefore, one may note that the syndrome of Little's Disease tends toward spontaneous improvement but that such improvement occurs very much later and is more incomplete in the lower extremities than in the upper.

To this muscular contraction is also added the nutritive shortening of the contracted muscles and the contraction of the fibrous tissues. This is a secondary effect. Whenever muscles become shortened they shrink and become sclerosed. Likewise, with limitation of motion the ligamentous structures of the joint and the peri-articular tissues become also contracted.

There are therefore, two elements in the clinical picture of Little's Disease.

First; contraction which often has a tendency to spontaneous improvement.

Second; retraction, the tendency of which is rather toward aggravation.

The treatment of Little's Disease comprises the following elementary stages:

1. Muscle education.

2. Correction of faulty positions.

3. Orthopaedic operations proper.

1. In regard to muscle education, which consists in massage, mobilization and gymnasium exercises, the point brought out by the author is that these exercises should be given in two sittings daily, especially in the beginning as fatigue appears easily and is likely to cause contraction.

Exercise and massage alone may be sufficient in very mild cases of Little's Disease. While it should be employed in all cases and especially in cases which have not yet reached the operative age, in many other cases it must be followed by redressment or Orthopaedic operation.

2. Redressment of faulty attitude and immobilization.

Such a procedure should be carried out under anesthesia followed by application of cast in hyper-correction.

The time of immobilization given by Lebrun is from ten to twelve days, by Lorenz one to two months, Frölich one to two months, by Calot three months. In fact, the duration of retention of cases will vary with intensity of spasms.

3. Orthopaedic operations.

The most frequent interferences are as follows:

Tenotomy of the tendo-achilles, tenotomy of the ham-strings, tenotomy of the adductors of the thigh and tenotomy of the flexors of the hips. These are all carried out with good result.

In regard to tendon transplantation the indications are very few and results doubtful in spite of good results reported by Hoffa, Codivilla, and others.

Osteotomies are rarely indicated.

In some cases muscle atrophy is such as to make arthrodesis necessary.

In younger children one will use massage and muscle education method. When at operative age, about 7 years according to Kirmisson, redressment and Orthopaedic operation will become necessary in addition. Frölich sets the operative age at 3 to 4 years. In cases of extreme spasticity it would be well to postpone intervention, however, and treat by rest in bed and hot baths for a time.

4. Radicotomie.

In the operation of Förster the sensory roots cut where they emerge from spinal cord if any resection of the spinal column is necessary in order to permit access to the posterior roots.

The Operation of Codivilla—Van Gehuchtens is less severe. There is less of bone resection and less hemorrhage. The roots resected by Förster method are the first and second sacral for contracture of the flexors of the foot, the third and fifth lumbar for the adductors and flexors of the thigh, so that all roots from second lumbar to the second sacral are cut with the exception of the fourth lumbar which supplies extensors of the knee.

In Van Gehuchens method the incomplete resection of the roots is done

but the results seem to be identical with those of Förster. The physiological action of this operation is evident. It destroys not only cutaneous sensibility, but also muscle and joint sensibility. The danger of the operation is that it produces disturbance of equilibrium as well as sensory symptoms. It is up to the post operative treatment to restore function especially as the muscle education is absolutely indispensible after radicotomie.

The Orthopaedic operation proper takes care of the contracture as well as the retraction. The tenotomy especially not only has an influence upon the mechanical position of the joint but also directly upon the muscle tone, which is lessened. Orthopaedic operations also, must be followed by muscle educational treatment.

Following the first operations there was considerable enthusiasm over Förster's method. But after careful study the results published may be summed up as follows:

All cases were improved, the majority considerably. Adductor spasms never recurred but those of the flexors of the knee did. Hunkin says that the results, while good, were less than expected. According to the author the results are in general only partial. They are limited to disappearing of the contracture but muscle re-education must be pushed for a long time on all operative cases. While the spasms and hyperexcitability of reflexes disappear, the re-education of the gait is very difficult. The dangers of the operation are known and do not need any special mention.

Contra-indications are, according to Förster: Cases in which process is progressing; cases of marked idiotism.

In regard to orthopaedic operations proper there is at hand much more experimental and clincal material from reliable observers. A comparison of the Förster's operation with Orthopaedic operations in general shows, that the latter have the advantage of not involving any great risk to the patient. Förster's operation should not be applied except as a last measure in cases resisting ordinary Orthopaedic operations. Biesalski, Frölich, and Broca express themselves in favor of Orthopaedic methods rather than Förster's method. Kirmission will have this method reserved only as a last resort in severe and rebellious cases.—*A. Steindler, M. D., Iowa City, Ia.*

Flat Foot. New Statement of Old Truth. L. R. G. Crandon. *U. S. Naval Medical Bulletin*, Jan., 1919.

Flat feet should be treated not as an anatomical, but as a physiological entity. The author does not believe in the use of plates, but advises a shoe with an unstable (rubber, or partly rubber) heel broad outside curves and wide toe to allow a gripping action.

The fact that many men with perfectly serviceable feet though flat have been rejected, and some with weak feet and high longitudinal arches accepted for government service is commented on; and tests by functions and not inspection advised.—*Edward S. Hatch, M. D., New Orleans, La.*

Vol. I, No. 9 SEPTEMBER, 1919 Old Series: Vol. xxii, No. 9

The Journal of Orthopædic Surgery

INFECTED WOUNDS OF THE ANKLE

BY P. CHUTRO OF PARIS.

In a recent communication in the Journal de Chirurgie de Paris, I described the technique and the indications for treatment of lesions of the ankle.

Upon the request of several colleagues, I have permitted myself to present before you the same subject.

Theoretically, I retain certain doubts as to the efficacy of the treatment of Willems for lesions of the ankle, especially when the arthritis is accompanied by a fracture, which is frequently the case in war wounds.

According to my personal experience, the treatment of Willems is admirable when there is no grave fracture of one of the important bones of the articulation.

The astragalus is adapted so exactly to the mortise that except in certain fractures by rifle-ball, all fractures of this bone give rise to a deformity which renders the movement of the joint very difficult. Again, it is not uncommon that several of the elements of the joint have been injured by the projectile. In this case, the fragments of bone, and especially those of cartilage, form a veritable partition of the synovial membrane, and they contribute to the retention of pus.

These facts, together with the facility with which the infection of the joint invades the neighboring tendon sheaths, impose the indication for the operation of astragalectomy, from the very first, in order to suitably drain the ankle-joint. All opinions seem to be in accord on this subject.

But the treatment does not always seem to give the desired result, and numerous amputations have been done long after the

primary operation, in order to obviate not only the phenomena of infection, but phenomena of another order, of which I will give a brief resume.

The alarming symptoms of the infection subside immediately after the astragalectomy, but at the end of several days, or of several weeks, one observes that the foot remains very swollen, that the wound shows exuberant granulations, and that it bleeds very easily. All movement becomes impossible at this time on account of pain, and also because of a true mechanical hindrance.

If one examines the patient several weeks later, it is seen that although the wound is closing well, the foot remains swollen, with a chronic oedema which obliterates all the normal outlines. The retro-malleolar depressions are effaced, the toes are immobile and contracted, the sole is round, that is to say convex, the foot tends to the equinus position, and the patient is entirely incapable of using it. Sometimes the lesion is painful, and the foot is affected with tactile hypersensibility, and alterations in the temperature and the color.

All this group of disabilities bring the surgeon and the patient to the conclusion of the necessity of an amputation which could have been avoided in a great majority of the cases.

What is the reason of all these difficulties?

I have already said that the infection itself counts for very little, because after astragalectomy there is drainage under good conditions; and although certain cases still retain neighboring fragments of bone in process of elimination, this fact alone would not account for the symptoms which have just been enumerated.

The most plausible explanation is the following: after astragalectomy has been done, the foot is generally immobilised at a right angle in one of the numerous appliances which have been employed during these past years. These appliances retain the foot well at a right angle, but they do not adapt themselves to the special conformation of the inferior part of the leg and of the posterior half of the foot. In reality, they are appliances which only serve to give a bearing point to the heel.

While the member is immobilised in this way, the bones of the leg drop backward; the mortise, which is no longer retained in place by any ligament, comes to be applied to the non-articular portion of the superior surface of the os calcis, at the same time that

the whole foot undergoes a dislocation forward. The consequences of this displacement of the bones of the leg backward, or of the dislocation of the foot forward (according to the manner in which one wishes to consider this movement) are of several kinds:

(1) A disappearance of the retromalleolar spaces is brought about, the tendon of Achilles coming closer to the bones of the leg.

(2) The border of the mortise, displaced backward, causes traction upon the flexor of the great toe, and then upon the common flexor of the toes, giving rise to a flexor contracture of the toes, and a plantar flexion of the fore part of the foot. The day that the patient abandons his apparatus, this same contraction of the toes will conduce markedly to the equinus deformity.

(3) The same tension produced by the mortise on the tendons acts also on the posterior vasculo-nervous bundles. The circulatory embarrassment is aggravated by the compression of the vessels, due to the disappearance of the retromalleolar spaces. The return circulation suffers especially, and the foot presents the signs of a permanent passive hyperemia, with cyanosis, sweating, and variations in the local temperature.

(4) The change in the position of the foot, and especially the change in the point of contact of the mortise, results in the os calcis, whose anterior part is normally elevated from 11 to 19 degrees, becoming completely horizontal, even coming in certain cases to present its posterior portion higher than its anterior apophysis.

All these lesions may be still further aggravated by lateral displacements at the level of the ankle. At the same time, the contraction of the tendon of Achilles is accentuated little by little, by the fact that the points of insertion are closer together.

When the vicious attitude has not been corrected in the early stages, the deformity becomes fixed, and the correction is very difficult. Sometimes, under anaesthesia, and after tenotomy of the Achilles tendon, the foot can be brought back to a suitable position. An ultimate treatment of massage, hot air, active mobilisation and re-education may complete the cure. In other cases, an orthopedic amputation may be counselled. When we have been obliged to resort to amputation we have employed osteoplastic methods with excellent results.

Before ending this resume of explanation, permit me to explain to you the manner in which our patients have been operated and treated in order to avoid all these unpleasant results.

In addition to cleaning the wounds of entrance and exit, we perform an incision in the form of an italic "S", commencing above the external malleolus and descending along the anterior aspect of the malleolus to the line of the ankle joint, becoming then almost transverse as far as the prominence of the tendon of the tibialis anticus, then becoming again longitudinal and descending 2 or 3 centimetres. An astragalectomy is done, and when the cleaning of the wound has been done, the foot is fixed in good position.

In order to fix the foot, one passes a bronze wire through the skin and soft parts of the inferior lip of the wound: this wire grazed the posterior superior border of the cuboid, and then following a recurrent path, it traverses the anterior border of the external malleolus and the soft parts of the other lip of the wound. The necessary drainage tubes were placed, and the wire twisted. This partial closure of the wound never presented any ill consequences, because there remained always a large opening, well exposed, which permitted the discharge of pus and liquids.

When the infection had spread to the sheaths of the postero-internal tendons, one added a debridement which extended to the joint.

The advantages of this fixation by bronze wire are the following:

(1) The cuboid is brought close to the external malleolus.

(2) The tarsus is projected backward.

(3) The anterior portion of the os calcis retains its normal elevation above the horizontal plane, and flat foot is avoided.

(4) The retromalleolar spaces become deeper than normal.

(5) There is no traction on the posterior tendons, nor compression of the vessels.

(6) The Achilles tendon is not shortened, and there is in consequence less probability of equinus deformity.

(7) The mortise, which is concave, rests above the articular surface of the os calcis, which is also concave: there remains, between the two, a cavity which will later be filled with a fibrous tissue, which will prevent bony anchylosis and will permit a certain mobility of the foot.

(8) The anterior tendons having their points of insertion nearer each other will gain in force and will contribute to the prevention of equinus.

The operation finished, the foot is immobilised at a right angle by a figure-of-eight bandage, extending from the heads of the metatarsals to the inferior ¼ of the leg.

In order to obtain a complete immobilisation, we were accustomed to apply an initial bandage as we have just said, and over this bandage there was added a second pad of cotton, very thick, and a new bandage is applied. The foot remains thus more immobile than in an apparatus.

The dressings were renewed at very long intervals, every 15 or 20 days. The bronze wire was removed about the fifth week. The patient commenced to walk on his foot between the fourth and fifth week, without crutch or cane; during the first days he was permitted to lean upon a chair or upon a comrade, but at the end of some days he walked alone.

It is unnecessary to wait until the wound is healed in order to have the patient walk. During some time, there was observed a little oedema of the foot, which bothered otherwise very little. It is always wise to advise the patient to stop after some minutes and raise his leg so as to aid the return circulation.

The results which we have obtained in this way, in war wounds as well as with patients in civil practice, are very satisfactory. The shortening is negligible almost, and when the patient retains a little mobility at the level of the ankle, he comes to walk without limping, and without one perceiving the disability existing at the level of the operated region.

Discussion.

Dr. Clarence L. Starr of Toronto said that the question of tarsal injuries and injury to the astragalus was one of intense interest, because all shell injuries to the foot followed by sepsis appeared hopeless as to final result. Most men thought the foot should be sacrificed and a stump made. Dr. Chutro had avoided this in injuries to the actragalus. Extensive tarsal injury made a very poor functionating foot. The astragalectomy under aseptic conditions in civil life, which is known as the Whitman operation, has given the only data upon which to base ideas of the functioning of the foot. Removal of the astragalus provided adequate drainage and displacing the foot backwards made a better weight bearing apparatus than any type of amputation. Dr. Chutro was to be congratulated upon the work he had done along the lines of the tarsus injuries.

Dr. Clarence L. Starr of Toronto said that he thought he agreed with Prof. Chutro, that the faults of the surgeon should not be blamed on Dakin's solution. There were some men who thought that Dakin's solution would do the entire thing. This was not enough but the personal touch of the surgeon with the patient should be followed through the course of after treatment. Professor Chutro had covered such a large field that it was impossible to discuss all the points. He would like to emphasize a few details: One was the acute character of the osteomyelitis; efficient drainage must be maintained until we reach

the stage in which the acute infection was eliminated; sequestra were usually formed, but it was better to let them alone until they separated, and then with their removal often the sinus was eliminated; secondly there were two things that kept a sinus open; foreign bodies, and a non-callapsible wall. The cavity might not go through the bone entirely, but with collapse of the wall, the sinus would disappear. In some cases a small sinus might open into a larger cavity; the cavity would never close until it was collapsed. One could excise the soft tissue and fibrous tissue wall, then reverse the cavity, by turning it inside out, bringing the wide portion to the outside and the narrow portion inside. Professor Chutro said one did not have bone formation from the bone itself. There was, however, a granulation tissue which became ossified and the cavity became filled to a large extent. In bone operations of that sort, it had been the experience of many, any of the speaker himself to see men treating a sinus from one of those two conditions, and without enlargement of the incision, trying to scoop out the cavity in a bleeding field, and so missing a foreign body, and causing a larger cavity. With a cavity of that sort, one should put on a tourniquet, then make an adequate incision and take out the foreign body, do a light curettage of the surface to get rid of dirty slough and granulation. This avoided tissue sepsis. The speaker said he had had large openings in the upper end of the tibia and had fully removed one side of it. This collapsed the cavity with satisfactory results. Attempts at transplanting muscle into the bone cavity below the knee joint had not been wholly satisfactory. One was never sure of filling the cavity entirely.

"NON-UNION FOLLOWING CORRECTIVE OSTEOTOMY OF THE TIBIA."

BY EMIL S. GEIST, M. D., F. A. C. S., MINNEAPOLIS, MINNESOTA.

Of the following two cases of operation on deformed tibiae which resulted in non-union, one occurred in my own work, while the other occurred in the practice of a Minneapolis surgeon. The latter case came to me for treatment of the bilateral un-united fracture. I deem it worth while to make a short report of these two cases as this is an operation which is frequently done without thought of the possible occurrence of any disastrous result.

The first case, the one which occurred in my own practice, was a healthy boy, two and one-half years old, who was born with a congenital unilateral deformity of the leg. The deformity was one of anterior bowing of the tibia at about its lower third combined with a moderate degree of inward bending (crus varus). Corrective brace was advised against as the bone was firm and inelastic. There existed no rickets.

On performing osteomoclasis, the bone was found to be quite sclerotic. Plaster was applied from toes to groin with leg in good position and the wound healed by first intention. On removing cast eight or nine weeks later, "delayed union" was found to exist, whereupon another similar cast was applied and worn for a term of two months. On removal of this, there still existed, as we hopefully termed it, "delayed union." A third similar cast was applied and the child allowed to put weight on the leg. X-ray at this time showed good apposition of fragments and some beginning absorption of the bone ends. Following removal of the third cast, there still existed no union. In the meantime, all laboratory tests, as Wassermann, etc., were made—all of them with negative results. Glandular extracts were injected with hope of cure and likewise negative results. After removal of the third cast, the leg was in good position, but there still existed non-union. Following this, a brace, well immobilizing the leg from toe to groin, was applied and the leg was kept under observation, for the following nine months, during which time X-rays showed progressive conical absorption of the bone ends. One and one-fourth year after operation, an Albee inlay operation was performed. Primary healing, but its end result was non-union.

At the expiration of another nine or ten months, another Albee inlay graft operation was done—this time by Ryerson, of Chicago, and myself. End result of this second bone graft operation is again failure of union.

Today the boy (who is now seven and one-half years old) has a straight leg, ununited, which he is using with a brace.

The second case occurred in a man thirty years old who "wished to have his bowlegs straightened so that he could get into the army." An operation was performed in November, 1917, by a surgeon who tells me that the bone was divided at the angle of deformity by means of a hand-saw. Healing was "per priman" in the right leg while there occurred an infection of moderate degree in the incision of the left leg, which infection cleared up fairly promptly under proper treatment.

In both legs, however, complete non-union supervened and the patient reported to me for the first time on February 17th, 1919, in the deplorable condition of having un-united fractures of both tibiae. Otherwise, he was an absolutely healthy young man with a negative Wassermann. He had been a good athlete before his surgical experience.

On February 19th, 1919, a typical Albee sliding graft operation was done on the right tibia which I am glad to say is entirely successful. On May 6th, 1919, the left leg was operated upon in a similar manner. As yet, it is too early to report on this.

These cases bring up the subject of non-union which I do not wish to discuss excepting to state that our knowledge regarding it is still far from complete. These two cases illustrate how we can obtain non-union in fractured bone where we have no interposition of foreign tissues and no constitutional disorders which we can recognize. I have observed from the beginning a case of simple linear fracture without displacement and which was well treated, in a healthy young farmer, which resulted in typical non-union and nearthrosis. I sometimes wonder whether there exists in some persons an idiosyncracy of their young osteoblasts toward the X-ray.

Discussion.

Dr. J. Torrence Rugh of Philadelphia, said he had had 3 non-unions following corrective osteotomies, one in a feeble minded child with thyroid condition; non-union persisted in spite of glandular extracts. At the end of 2 weeks when the stitches were taken out the flaps fell wide apart; there was no union of the soft parts. Idiosyncracy was a term to cover ignorance. Experience lent sup-

port to the idea that the internal secretions were at fault. In many cases the administration of glandular extracts would stimulate bony growth and secure firm union. This was a fruitful field for further investigation, because of the dire results which followed failure in these operations.

Dr. S. L. McCurdy, Pittsburgh, Pa., said that in some cases the pull of the fibula prevented the fractured ends of the tibia coming together, by the swing of the tibia over the fibula. He would like to know how Dr. Geist cut his bone. Union could sometimes be secured by making a very long oblique cut through the bone. Where the fragments were kept apart by an angular position, it was necessary to shorten the fibula. It might be found to be a question of mechanics rather than nutrition. A bone plate to make a bridge and lift into straight line would help, as in fracture of the radius of the forearm.

Dr. J. Torrance Rugh of Philadelphia said he had shortened the fibula and got good union in the ends, but less than a year afterwards there was complete absorption at the site and then there was non-union of both bones.

Dr. H. P. H. Galloway of Winnipeg, said he had had two such cases, one in a young child, and he finally came to the conclusion that there was a congenital psuedarthrosis present which had not been recognized. Another was in an officer, 26 years of age, discharged from service, and who wanted his bow legs corrected. Union was very slow after operation, at the end of several months the man was able to walk, but still had the plaster cast. Dr. Geist had mentioned that his osteotomy was performed with a hand saw; possibly this was the cause of the non-union as the osteoblasts had probably been destroyed by the heat generated by the saw. The osteotomy should be done with a chisel and not a saw; somewhat more traumatism resulted, but this was advantageous as regards subsequent union. It was a good plan to scarify the shaft of the bone in the neighborhood of the osteotomy.

Dr. J. D. Griffiths of Kansas City said the lower third of the tibia was the hardest part to get union because of the poor blood supply. One should remember that metabolism had much to do with the question. Dr. Rugh had sounded a toosin that there was endocrinal disturbance. The speaker said he had found there was thymus disturbance with low blood pressure in long delayed union of the tibia, where there was no evidence of syphilis or tuberculosis. Glycerophosphates would be found to have an influence and in cases with low blood pressure, pituitary could be used.

Dr. W. Truslow of Brooklyn, said that in a case he had treated of a bow-legged child of 4 years old, no union was obtained after open osteotomy. The family doctor suggested a shot-gun prescription, including calcium phosphates. Bony union promptly followed its use.

Dr. John Ridlon of Chicago, said he was connected with the Home for Crippled Children for 20 years, and he had not had any cases of non-union from osteoclasis during that time. Some years ago a widow had come to consult him, bringing a child with bow legs. She wanted to marry a rich husband, but thought that the bow-legged child would interfere with the match. The speaker said he broke the child's legs with 6 fractures, and in four weeks the child had firm union of the bones and in 5 weeks he had a step father.

Dr. Emil Geist, in closing said that he supposed he had reported something extremely rare, but apparently it was not so.

Dr. R. Hammond, Providence, R. I., said that he had had one such case, in a colored child. At the end of three months there was non-union at the site of the fracture, although the bone was in perfect position. There was evidence of bone atrophy. During the operation under light anesthesia the child died, and it was thought probable that there was disturbance of the endocrinal system.

PRELIMINARY REPORT OF LENGTHENING OF THE QUADRICEPS TENDON.

BY GEORGE E. BENNETT, ASSOCIATE IN CLINICAL ORTHOPEDIC SURGERY JOHNS HOPKINS MEDICAL SCHOOL.

Loss of flexion of the knee joint following trauma or inflammatory lesions of the femur, and involving its adjacent structures, has been seen frequently enough to suggest its consideration as a problem in surgery.

Nearly everyone engaged in extremity surgery has seen quite frequently, as the end result of a fracture or inflammatory disease of the middle or lower third of the femur, a healed wound with no damage to the knee joint, but with a permanent loss of complete or partial flexion of the knee, due to adhesions or contractions of the muscles of the thigh. Feeling that the muscles forming the tendon of the quadriceps femoris were the structures at fault in this type of case, we have operated upon and lengthened the same with results that we believe justify the publishing of this preliminary report.

In order that the subject may be considered in an orderly and concise manner, we shall attempt to divide it into four sections. First, anatomical consideration; second, physiological consideration; third, pathological consideration, and fourth, surgical consideration.

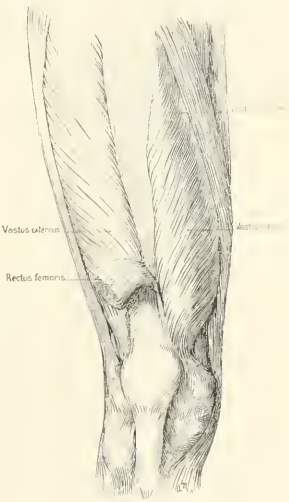
Anatomical Consideration.

A most concise description of the elements forming the quadriceps tendon we find in Sobotta-McMurrich textbook from which we quote. A very significant fact to be noted is that the vastus intermedius is closely associated with the lower third of the femur, and that the tendinous sections of the same are inseparably united with the vastus lateralis (externus) and the vastus medialis (internus), making it possible by adhesions of the vastus intermedius to prevent the function of the vastus lateralis and vastus medialis.

"The quadriceps femoris consists of four different heads, the most independent of which, the rectus femoris, unites with the remainder only in the lower portion of its course. This head passes over two articulations, while the remaining three are intimately adherent with each other and extend over the knee joint only.

The rectus femoris is a long, thick, decidedly spindle-shaped muscle, which is situated in the anterior femoral region, lying for the most part immediately beneath the deep fascia. It arises by a short, strong, bifurcated tendon, one part of which comes from the anterior inferior spine of the ilium and pursues the same direction as that of the muscle itself, while the other proceeds from the

Sketch No. 1—Showing formation of the quadriceps tendon.



Sketch No. 2.—Rectus detached and retracted.

upper margin of the acetabulum and joins the origin from the anterior inferior spine at a right or obtuse angle, the two together being continued downward as an aponeurosis upon the anterior surface of the muscle. The fibers of the muscle do not run longitudinally, but diverge downward and backward toward the insertion from a tendinous strip in the middle of the muscle. The flat tendon of insertion commences upon the anterior aspect of the muscular belly a few centimeters above the patella and unites with the remaining heads to pass to the upper margin of this bone.

The vastus medialis (internus) is a large, flat, thick muscle situated in the anterior and internal femoral regions. Its origin

is from the inner lip of the linea aspera of the femur, where it is adherent to the insertions of the adductors. Its fibers run downward and forward, some of them being inserted into the upper margin of the patella with the common tendon and some of them passing independently to the inner margin of this bone. The greater portion of the muscle is situated in the lower third of the femur; its outer margin is fused with the vastus intermedius.

The vastus lateralis (externus) is an unusually strong, large, flat muscle, which forms the chief bulk of the musculature of the external femoral region. It is stronger than the medialis and does not extend as far downward as this muscle, being situated chiefly in the upper and middle thirds of the thigh. It arises from the outer lip of the linea aspera as far upward as the greater trochanter and to a certain extent from the outer portion of the latter prominence, and its fibers run quite obliquely from behind forward and from above downward, the direction of the upper fasciculi approaching the vertical.

The entire external surface of the muscle is covered by a broad aponeurosis; its inner margin conceals the greater portion of the vastus intermedius, with which it is inseparably connected, and it is inserted by means of the common tendon into the upper and outer margins of the patella.

The vastus intermedius (crureus) is a flat muscle, the anterior surface of which is tendinous and distinctly excavated to accommodate the overlying rectus femoris. It is the least independent of all the heads of the quadriceps, since its lateral margins are inseparably connected with the other two vasti. It arises from almost the entire length of the anterior surface of the shaft of the femur, and its fibers pass from behind downward and forward into the anterior tendinous surface of the muscle and subsequently into the common tendon of the quadriceps. The lower fasciculi of the vastus intermedius pass to the joint and are known as the m. articularis genu (subcrureus).

The common tendon of insertion of the four heads of the quadriceps arises immediately above the patella by the union of the tendon of the rectus with those of the vasti. It embraces the entire upper and lateral margins of the patella, the latter structure simply serving as a sesamoid bone for the tendon, which is continued to the tuberosity of the tibia as the patellar ligament. The

actual point of insertion of the quadriceps is consequently this roughened process of the tibia."

The blood and nerve supply is only mentioned to state that they in no way interfere with the field of the proposed operation.

Physiological Consideration.

It is hardly necessary to enumerate the functions of the muscles entering into the guadriceps tendon.

Some very evident facts are known regarding the adaptability of muscles when a portion has been made useless by disease or destruction. We see such instances in the gastrocnemius and soleus, where a portion of these muscles has been completely destroyed, and yet the remaining part will function and produce a useful foot.

Another very evident fact is that muscles will function with good power when the distance between their normal origin and insertion has been lessened. One frequently sees a good, powerful, useful leg with a marked shortening of the femur, resulting from loss of substance, faulty position, etc., from complicated fractures. If a group of muscles will compensate and adjust themselves to this condition, there seems to be no reasonable argument why they will not do the same if the tendinous section is lengthened, making them undergo relatively the same change in order to function that they would undergo if there was a loss of substance of some inches of the bone itself.

Experience in paralytic disease, as in anterior poliomyelitis, has proven that full power of all the muscles of the anterior thigh is not necessary for a well functioning leg, except in performing special feats. Ordinary walking requires only a limited amount of power. One would feel free to state that a loss of one-third of the full power of the quadriceps would not interfere with the ordinary function of the leg.

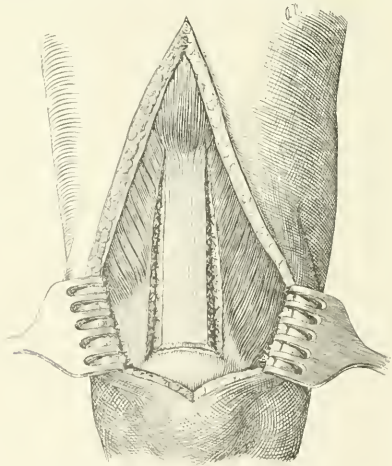
Pathological Consideration.

Under this caption one must not only consider the actual proven facts that it has been our pleasure to demonstrate, but also the possibilities.

The quadriceps tendon, owing to its location and formation, particularly in its lower and middle thirds, lends itself easily to being fixed to the femur by adhesions, since it has no protective

tendon sheath between it and the bone, and because it is subjected to a great deal of trauma associated with fractures and disease. It might at this point be well to consider an anatomical fact, which is, that the crureus and the vastus internus and the vastus externus are inseparably united in their tendinous formations in the lower third of the femur, so that adhesions of the crureus would result in putting out of commission the greater part of the vastus internus and vastus externus.

Long immobilization with a tendon in complete flexion, will result in the shortening of this muscle and tendon to an extent which in a great many cases results in permanent disability, and resists all other treatment except operative treatment. We see



Sketch No. 3.—Incision separating central section of quadriceps tendon.

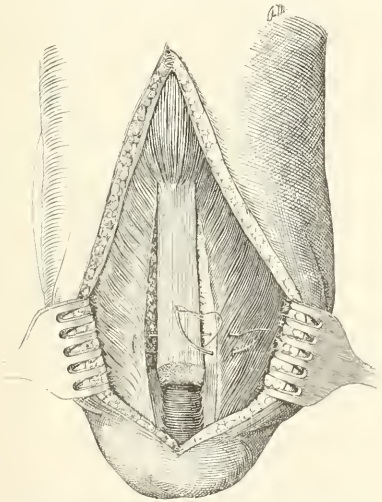
many instances of this in the contraction of the tendo-achilles, where the foot has been maintained in plantar flexion over a long period of time. We see no reason why the same condition would not occur in the quadriceps tendon if the leg is held in its fully extended position for a long time.

To sum up the pathological conditions:—One would have the actual tendon contraction due to long fixation in extended position,

plus adhesions between the muscles and the osseous structures. In one instance we have even seen adhesions between the muscles themselves, which resulted in a painful resistant scar, which prevented full use of the leg.

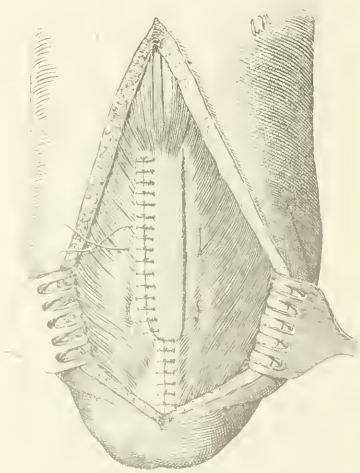
Surgical Consideration.

As has been stated before, one very frequently sees complete or partial flexion of the knee joints from conditions already mentioned, in which the joint itself is perfectly normal, and where the lesion has not been near enough to the capsule to cause any particular change in the same. The question arises:—what are the structures that are causing this loss of motion? It must be some lesion of the anterior thigh, which results in a fixing of the muscles that control the extension and flexion of the knee. We often see individuals who have ten or fifteen degrees of flexion with good power of extension, all of this motion being accomplished by sections of muscles which are not involved by adhesions. When the



Sketch No. 4.—Knee flexed, pulling patella free from portion dissected.

leg is forced beyond this point of flexion, one meets with a sudden shock and one can feel the quadriceps extensor tendon drawn taut. If we analyse carefully the facts associated, knowing that muscles will accommodate themselves to very unusual mechanical obstacles, we see no reason why an attempt should not be made to explore the anterior thigh and to lengthen the quadriceps tendon, feeling certain that the muscles will accommodate themselves to this condition.

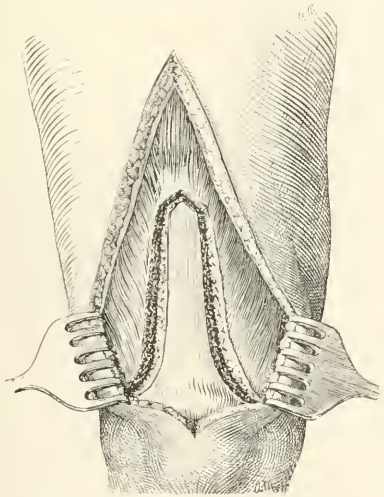


Sketch No. 3.—Method of suturing

This operation (undertaken by the writer) has been accomplished in two ways. The method used in the operation depends upon determining which particular section of the muscle is adherent. In the first case reported in this article, it was principally the fibers of the rectus which were causing the complete loss of motion, and in this case we separated the middle two-thirds of the quadriceps tendon from the patella, as shown in sketch No. III, then forcibly flexed the knee, and re-attached it at a higher level, stitching together the vastus internus and vastus externus, and fixed the retracted central fibers of the quadriceps to the new tendon made by the vastus internus and vastus externus, as shown in

sketches Nos. IV and V. We, however, feel that this particular type of case does not often exist.

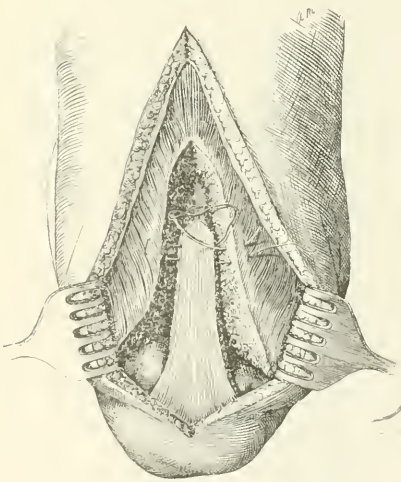
After having examined a number of patients who show loss of flexion as the result of fractures of the lower third of the thigh, which requires plating or long immobilization because of slow union, we feel that it is then that actual shortening and adhesions between the deep central fibers of the quadriceps (particularly the crureus, vastus internus and vastus externus) take place, and limit the flexion of the knee joint beyond a few degrees of motion.



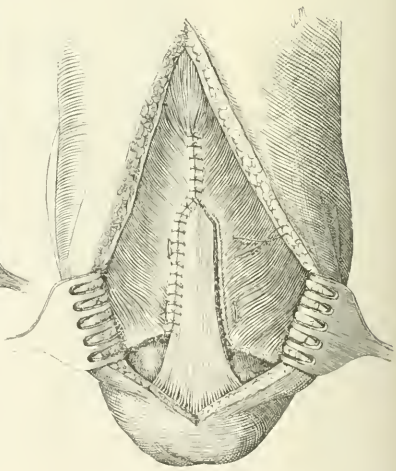
Sketch No. 6.—Incision detaching central section of quadriceps.

Operation shown in sketches Nos. VI, VII and VIII shows the method of handling the same. It consists in severing the central section of the tendon at the point of adhesions, splitting the vastus internus and vastus externus free, and separating the attachment of these muscles from the patella, leaving the central section with a broad attachment to the patella, forcibly flexing the knee, and pulling down the section dissected, as shown in sketch No. VII. The next step is the sewing up of the structures in such a way as to

give the greatest amount of strength. The vastus internus and vastus externus should be firmly united to the patellar tendon, the sections immediately above should be sewed together with either strong silk, kangaroo tendon or chromicized cat-gut, the leg then fixed in a flexion position of about eighty degrees for a period of three weeks. At the end of this time the plaster is removed, and the leg allowed to be fully extended, giving passive motion each second day. This is suggested as a means of making sure that we



Sketch No. 7.—Flexing knee, pulling dissected portion downward.



Sketch No. 8.—Suturing.

have overcome all contractions, and to allow the leg to subside from the acute trauma of operation before fully extending the same. Emphasis should be put upon the fact that motions are passive, and that no effort to use the quadriceps should be made until at least four weeks have elapsed. Massage and stretching as indicated.

REPORT OF CASES.

Case No. 1. N. C. Age 34.

Admitted to Johns Hopkins Hospital January 19, 1917.

Complaint—Stiff knee.

Family History—Father and mother, two brothers and two sisters living and well. No history of tuberculosis, heart, kidney or malignant diseases.

Past History—Has had measles, whooping cough, chicken pox and mumps. Has had several severe colds. The rest of the past history is negative.

X Ray of knee before operation.

Present Illness—Onset after injury to back at the age of 6 or 7. Following the injury the patient was unable to sleep at night for about one month. Then the right leg became swollen and there was marked pain in it. Patient was confined to bed six or seven weeks. After this he walked on crutches. In the meantime abscesses had formed and broken down. Relief from pain after the abscesses broke was marked. Abscesses continued to form at the rate of about two each year. At the age of ten an abscess appeared on the left clavicle, that was treated surgically, and one on the right arm. Several pieces of bone have come from the thigh abscesses at different times. At the age of *fifteen* the right knee became stiff and has remained so ever since. Since twenty-one he has had no more

Photograph before operation

Photograph functioning leg, taken April 1, 1919.

abscesses. Comes into the hospital to see if motion can be obtained in the knee.

Physical Examination—Patient is a well developed and fairly well nourished white man. The examination is essentially negative except for a scar over the left clavicle and the right arm and for the condition of the right leg. There is marked atrophy of the right thigh and there are scars of old abscesses on the outer aspect of the right thigh. The right knee is stiff. Hip movements are normal.

Impression—Osteomyelitis of the right femur with adhesions of the thigh muscles.

Operation—January 27, 1919. Lengthening of the quadriceps, as shown in sketches Nos. III, IV and V.

Patient has a well functioning leg, as shown in photographs taken April 1, 1919.

Memo—Illustrations—

X-Ray of hip
X-Ray of knee before operation.
Photographs of operation.
Photographs taken April 1, 1919.

X-Ray—Osteomyelitis upper third femur, which tied down the fibres of the rectus.

Case No. II.

Mrs. M. B.

Comminuted fracture of right patella. August 17, 1919.—Open operation and wiring. Immobilization in extension. Massage begun October 20, 1917.

Manipulated under anaesthesia and continued treatment until operation February 4, 1918, at which time patient had 35° of motion, as shown in X-Ray taken with leg held in forced flexion.

X-Ray before operation.

Ten weeks after operation 125° of motion obtained, as shown in X-Ray taken in forced flexion.

The operation performed in this case is shown in sketches Nos. VI, VII and VIII. We believe that this type of case should be placed in the class of true contractions of the quadriceps tendon.

Memorandum of the illustrations—
X-Ray taken before operation
X-Ray taken 10 weeks after operation.
Photographs four months after operation.

X-Ray ten weeks after operation.

Photograph four months after operation

CASE No. III.

G. J. G. Aged 23. White Male.

Admitted to Johns Hopkins Hospital March 12, 1919. Discharged April 29, 1919.

Family History—Father died of heart trouble. Otherwise negative.

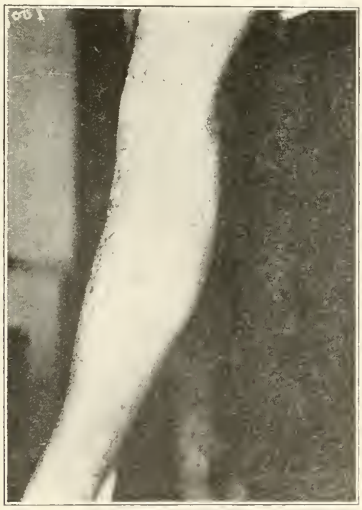
Past History—Usual childhood diseases. Frequent colds in head. Otherwise negative.

X-Ray of fractured femur with plating, before operation.

Present Illness—In an automobile accident June 25, 1915, patient sustained a compound fracture of the right femur, eight inches above the knee, and a simple fracture of the left femur, six inches above the knee. Both limbs were put up in traction and the wound on the right thigh irrigated daily. At the end of three weeks an open reduction of the fracture on the left was done, the fragments being plated and the limb being put up in a long plaster hip spica. The wound on the right closed at the end of nine weeks, at which time a plating operation was done on this side too, and a long spica applied. The cast on the left side was cut an inch or so shorter at various times, so that it was not until October of that year that the knee joint was exposed. By the end of December the right knee was also freed for motion, and massage, and later manipulation were instituted. However, legs remained stiff at knees. In August, 1918, several manipulations under anaesthesia were unsuccessful. On September 12th the bone plate of the right was removed without improvement. Stiff knee condition remains as on admission.

Physical Examination—Essentially negative with the exception of the extremities.

Patient walks with knees stiff. There is marked atrophy of the thighs. Left knee joint permits about 15° of flexion, when motion is stopped by a taut quadriceps tendon, apparently tacked down to femur several inches above the knee joint. Knee joint itself is apparently negative. On the right side there are about 10°



Before Operation.

of hyperextension at knee with ability to straighten limb. Here too knee seems to be negative, the restricting factor being a taut quadriceps tendon.

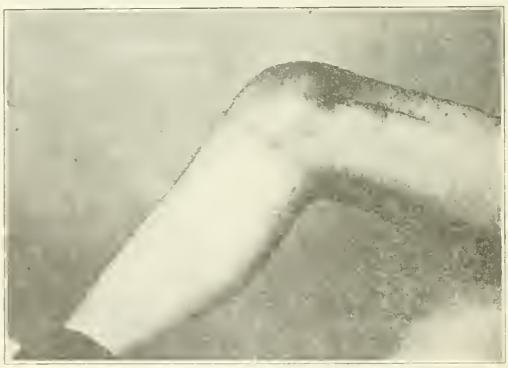
X-Ray examinations on March 13, 1919, showed knee negative for bone or joint changes.

Operation—March 13, 1919. Lengthening quadriceps tendon.

Under ether anaesthesia the patient was operated on for lengthening of the quadriceps femoris. All the tissues at a level of four inches above patella were found adherent and attached to femur below. The anterior part of the quadriceps tendon was cut

free at its superior and lateral margins and by forcible flexion at knee, pulled down. The tendon was sewed in place in its new position and the gap left by its being slid down, was covered by the tissues lateral to the space. Tissues above were then closed and a plaster cast applied from groin to ankle, with limb flexed at 80°. Patient left the table in good condition.

The post operative course of the whole was uneventful. Some ecchymosis appeared about the thigh. The temperature went up to as high as 101 on several occasions the first week. After that, however, condition was excellent. On the 27th of March the cast



Photograph six weeks after operation

was removed. The wound was found healed per primam. The knee could be flexed to 100° without any discomfort. Following this a mild course of massage and later manipulation, was begun.

At time of discharge patient was able to actively extend his knee to within 15° of normal. Limb could be flexed to 80°. There was practically no local discomfort.

This patient at date of writing (April 20th, 1919) is walking about the wards without support with a good functioning leg.

Memorandum of illustrations—

X-Ray before operation.

Photograph before operation.

Photograph six weeks after operation.

A SELF-CORRECTING BRACE FOR LATERAL CURVATURE OF THE SPINE.

BY DR. WALTER TRUSLOW, BROOKLYN.

Presented at the American Orthopedic Association, 1919.

This frame consists of two parts, a lower fixed segment and a laterally-moving segment. The fixed half embraces the pelvis and lower trunk to the level of the vertebra which marks the change from the lower to the higher spinal deviation. It is thus made like the lower portion of a Knight spinal brace, with the addition of a mid cross-bar. The lower half carries the two corset flaps. The upper segment is a parallelogram of brace steels, so attached to the upper end of the fixed half that it may move laterally and only in the direction of correction of the badly carried upper trunk. The lower ends of its four uprights are so hinged to the mid cross-bar of the fixed segment as to allow motion in the lateral plane only; a set-screw acts as stop to prevent motion in the direction which would increase deformity. To the upper corners of the movable half are attached shoulder straps, as in the Knight spinal brace. The parallelogram arrangement of the uprights and compensatory hinges, at the upper ends, insure maintenance of support of the "low shoulder"—it affords lateral carriage of the upper trunk, not lateral bending. To give also direct corrective pulls on the two spinal deviations, hand-like pads on the two side prominences, with arm-like horizontal rods, are carried from the uprights; and traction is made when these uprights move laterally. A downward projection of one of the lateral uprights insures this pressure on the lower spinal deviation, on the principle of leverage of the first order; the attachment of the upper traction arm to the middle upright, above the latter's fulcrum on the mid cross-bar, gives pull on the upper spinal deviation, on the principle of leverage of the second order. Attention is again called to the set-screw, which not only stops the lateral motion in the faulty direction but which by adjustment causes the correcting lateral motion to be as great or as little as is desired.

In the treatment of lateral curvature of the spine, this brace has its place between the use of rapidly correcting plaster of Paris

jackets and of intensive muscle training. It should be ready for use as soon as the last corrective jacket is discarded; the rapidly corrective exercises are started at the same time. Practically it may be used while considerable deformity still exists. With a six to eight per cent deviation and rotations not greater than ten degrees, it is a useful adjunct to the further correction which proper exercise will insure. Its constantly self-correcting and correction-holding elements, together with extensibility to meet growth, make it useful much longer than any brace which has not these features.

TREATMENT OF UNUNITED FRACTURES

F. C. KIDNER, F. A. C. S., MAJ. M. C., DETROIT.

The terms ununited fracture and non-union are purely relative ones, and are much too commonly used. As a matter of fact non-union of fractures is extremely rare if proper mechanical treatment is used. Broken bones have an extraordinarily persistant tendency to unite if given a chance. Non-union frequently is the invention of the surgeon, who is not content to give nature time or who does not know the proper use of splints. Although all fractures are ununited from the moment the injury occurs until complete solidification is established, the term ununited fracture should not be used until periods of time much longer than most of us care to wait have elapsed. The process of new bone formation in fractures is dependent on so many factors of which our knowledge is incomplete, that we should train ourselves to wait and watch without interfering with nature's handiwork.

Delayed union is the result of many causes, not the least of which is meddlesome surgery. For this reason so called non-union in simple fractures is more common in civil practice than in war time. In civil life the surgeon has time to watch the daily progress of the fracture, and to change the treatment constantly. He tries to hasten union, because his patient is in a hurry. In war the surgeon is greatly overworked and he is forced mercifully to neglect his fracture cases, and to be content if his apparatus is holding. In war the patient has unlimited leisure, and can be kept in bed. Thus it happens that in war fractures physiological, and continuous rest is more commonly the fortunate lot of the fractured bone. We all know that irresistible temptation to change the splints, in the hope of getting a little better position, which often overwhelms us to the ultimate detriment of the case. In army hospitals we avoid this temptation in the happy knowledge that our extensions are holding.

Delayed union may be caused by systemic changes such as malnutrition or syphilis. Such causes must be recognized and removed. If they are not removed they may cause ultimate non-union. Delayed union may be caused by extremely faulty position, but rarely non-union. In the army we marvelled daily at the tremendous obstacles in the way of bad position bones overcame and united firmly. Delayed union may be caused by sepsis, but septic

fractures with very few exceptions do unite. It may very rarely be caused by the intervention of muscle and fascia between the fragments. If this occurs ultimate non-union usually results. This cause is more common in civil life than in war because the majority of war fractures are open ones and are explored at the time they are received.

In war surgery delayed union and non-union were most frequently caused by considerable loss of bone substance, incurred at the time of the injury or through excessive zeal on the part of the surgeon who explored the fracture. The most serious, difficult and frequent problems of the orthopaedic surgeon were the cases of greater or less loss of substance in the continuity of the shafts of long bones. Those that were caused by enemy missiles were less difficult than those caused by the enthusiastic surgeon who had done a thorough "debridement." Debridement in conservative and skillful hands saved many limbs and lives, but debridement which ruthlessly removed loose bone in the hope of getting asepsis was an unmixed evil. Better far the controllable sepsis from infected bone fragments than the aching void of the aseptic radical cleansing of the compound fracture. Even very septic and apparently devitalized bone fragments had an uncanny knack of coming to life and acting as bone grafts. When they were aseptically removed only the troublesome and always doubtful bone transplant could repair the damage.

Most cases of ununited fractures then are not true examples of non-union, but are really only delayed union, and are to be treated conservatively as such for very considerable periods of time. Conservatism with proper mechanical aids in skilled hands will in a large majority of cases save time over surgical operations, which aim to hasten union. This is true of ordinary civil life fractures, but is especially true of war fractures. In war fractures, because of recurrent sepsis following bone surgery, is an ever present menace. No set period of time elapsed after healing of the wound insures against this menace. Three months, six months, a year, give increasing safety, but I have seen pus pockets in the deep tissues at operations on fractures eighteen months after complete of the wound. And these operations have been followed by a streptococcus infection rivalling in severity the original sepsis. Operative interference then in delayed union is to be discouraged, except as a last resort.

Certain factors in the prevention of non-union are of the utmost importance. First and most important of these is the immediate alignment of the fragments by efficient traction, applied in the direction of the axis which muscle pull gives to the shorter or less easily controlled fragment. The heaviest traction applied to a fracture of the upper third of the femur, while the leg is abducted and extended, will not give good alignment of the fragments, nor will it do so if applied to a fracture of the lower third if the knee is straight. The traction must be in the line which the shorter fragment naturally takes; in the first example abduction and flexion, in the second with the knee flexed to a greater or less degree. It is impossible to pull a fracture of the upper third of the radius into alignment with the hand pronated. Immediate reduction, that is, within the first hour or two, is of great importance for two reasons. First, because less traction is needed to obtain alignment before irritative tonic spasm is set up in the muscles. Second, because the early blood effusion from the bone fragments contains many osteoblastic elements. If reduction is obtained before this effusion has stopped and coagulated, then the bone forming elements are better distributed and arranged to form a plastic callus and bring about prompt union. Good alignment once obtained by traction must be maintained constantly, and for a considerable period of time.

Early alignment by traction is most important in all fractures, but hardly second to it in importance in badly comminuted fractures is the retention in place of all possible bone fragments. Too much stress cannot be laid on this. No fragment of bone should be removed unless its presence so seriously blocks the depths of the wound, that safe drainage cannot be established. The removal of bone fragments to obtain aseptic closure, or to avoid drainage is not justified. Most bone fragments which have any attachment to soft tissue will in spite of sepsis live and produce new bone. Bone fragments which are wholly free will often acquire new attachments, and act as grafts.

If delayed union occurs it is most commonly from neglect to obtain and hold good alignment, or because of considerable loss of substance, but the other factors, systemic disease, sepsis or muscle intervention, occasionally are causative agents. Of these three, medical examination and treatment will remove the first, and efficient drainage the second. The third is only recognized with

difficulty. It should be suspected where examination shows excellent alignment, but where union does not take place in spite of long continued rest, and when no other cause can be found. It can be removed only by operation.

To overcome bad position, and obtain good alignment, when union has been delayed for some time, requires much skill and judgment. It can usually be done, however, by appropriate mechanical means. For example, the accurate application of a pair of calipers or tongs with traction to the lower end of a femur which has been long displaced backward, will often pull it up into place and, by bringing fresh bone surfaces in contact, produce union. In the application of the calipers the greatest care must be taken to apply them at the exact anteror posterior position to obtain the best leverage. In the upper end of the humerus extreme abduction with strong traction may rotate the shaft on the neck in such a way as to give good apposition, and ultimate union. Or again, in the humerous simple extreme abduction by taking off the pull of gravity, may allow the fragments to come into close contact and bring about union. This last fact is most important, as many humeri fail to unite because the weight of the lower arm and forearm acting constantly over long periods of time actually pulls the fragments out of contact.

To overcome delayed union caused by loss of substance is frequently impossible by purely mechanical means. In small gaps up to one or one and a half inches it is sometimes justifiable to remove traction and encourage shortening in order to get the bone ends in contact. This is particularly true of the humerous and forearm. Excellent useful results may be obtained in this way. If the gap is too long to permit this procedure, then maintenance of good alignment and the exercise of inexhaustible patience will sometimes achieve a result. Nature will do much in the way of autogenous grafting. Several times I have been chagrined as I waited for the disappearance of sepsis before doing a bone transplant, to watch by means of the X-ray a delicate line of new bone gradually bridging the gap. This may start from the ends, the fragments, or from periosteum left scattered along the gap. Such autogenous spontaneous grafting may obviate the necessity for surgical interference.

The more one sees of this tendency of bone to bridge gaps in its continuity, the more one is surprised at the extraordinary vi-

tality exhibited by the smallest fragments of bone and islands of periosteum. Early examination of fractures from which large amounts of bone had been removed by the original injury or by surgical interference often gives the impression that there can be no vital bone forming elements between the ends of the main fragments. The small pieces of bone or shredded periosteum look too badly infected or de-vitalized ever to take up any osteogentic function. Yet the X-ray will reveal during the later weeks or months islands of new bone which can have no other origin than these despised fragments. One is forced by such experiences to the belief that bone instead of being one of the least resistant structures to infection and trauma is really one of the most resistant. Part of a fragment may die and come away as a sequestrum, but part of it is pretty sure to live and grow.

Massage and other similar measures to maintain and stimulate the nutrition of the soft parts in the region of a slowly uniting fracture are of undoubted value in promoting union. Manipulation or other systematic means of irritating the fragments are usually harmful. They only serve to increase fibrous tissue formation. It is then most important if we are to forestall non-union to do two things, first to obtain early accurate alignment, and to maintain it continuously for long periods and second, to preserve all possible fragments of bone and periosteum.

When all external mechanical devices to overcome delayed union have been exhausted along with the patience of all parties concerned, there do remain a certain number of true ununited fractures. These must be treated by open surgery. The choice of various operations is open to us. Metallic, ivory, boiled bone plates, pegs, tubes, and screws, wire, magnesia, heterogenous and homogenous and autogenous bone grafts and simple joinery of the refreshed ends have all had their advocates and popularity. From them it is our duty to choose only those which the experience of large numbers of careful honest surgeons, working and observing over long periods of time, has shown to be consistently successful. In making our choice we must be guided by many considerations. We must remember the difference between the ordinary run of civilian fractures, and the fractures of battle with their treacherous sepsis. We must realize that the healthy tissues of the civilian will stand much more surgical insult than will the torn, bruised, septic tissues of the soldier.

It is undoubtedly true that many fractures in civil life do unite in spite of the insult of the metallic bone plate, but they do so only because there is enough excess growing power to overcome the atrophy the plates cause. This is rarely true in war fractures. This fact was very prettily exemplified by the experience of two American bone plate artists, who had never had a failure, with whom I had the pleasure of working while orthopaedic consultant in England. These men insisted that certain fractures under their charge could not be held in good position by any known apparatus, and that plating alone could bring about union. At last I reluctantly consented and they did a series of twenty or more cases in spite of G. O. No..... Careful investigation later revealed that over sixty percent of these cases were complete failures either because of active sepsis stirred up or because the bones would not grow. Bone plates do unquestionably cause bone atrophy. The X-ray will prove this. This atrophy is often limited to the immediate neighborhood of the plate, the rest of the bone growing well and uniting. The femur is the only bone which has enough size to allow this double process of atrophy and growth to go on in a really satisfactory manner. There is no question that bone plates increase the risk of sepsis. When applied to actively septic fractures, as they were by a number of surgeons in 1916, 1917 and 1918 they are positively dangerous. A questionnaire sent out in the summer of 1918 to 35 or 40 prominent English, French, Italian and American surgeons revealed the fact that only one was still using the bone plate in freshly infected fractures. In the old septic fractures of soldiers it is rare that the metallic plate can be made to stay clean and hold. Wiring is open to the same objections that metal plates are. It causes atrophy by pressure, inhibits bone growth and is prone to infection. It has the added disadvantage of instability. Metallic bands have the same inherent weaknesses. With boiled bone or ivory plates, screws and pegs I have had little experience, but believe that they act as irritants and fregn bodies and will therefore be inefficient in a large percentage of cases.

What then are the best operative procedures? They are those whose keynote is the most absolute simplicity. They are those which do the least possible trauma to soft tissues and to the bone itself. The easiest, simplest operations done in the easiest and simplest way are the best. In fractures where there is little loss of bone substance an operation which removes scar tissue and

freshens enough of the ends of the fragment so that fair sized areas of bleeding bone surface can be brought in contact will, if the after treatment is efficient, usually suffice. A cat gut or other absorbable loop thrown round the ends of the bones often helps to steady them. After such an operation the mechanical care is as important as it was after the original injury. Sometimes in order to get good bone surfaces in contact it is necessary to shorten the fragments and to make in them some form of simple interlocking joint. This I find can be done in most cases more satisfactorily with mallet and chisel than with the motor instruments.

Where bone substance is gone, the bone transplant becomes necessary. In the large bones femur or tibia where bone nutrition is good, any type or graft of transplant is usually successful. In small bones or in large ones which are much crushed and eburnized, the type of graft must be very carefully selected. In the radius and ulna nutrition of the ends of the fragments for two or three inches is usually very poor. In such bones if we do a graft which necessitates grooving or drilling or insult to the medullary cavity, failure is a too frequent occurrence. In such cases apparent union takes place within two to three months, but all too frequently at the end of that time, the union begins to weaken and gradually the fracture again become a loose one. The explanaion of this fact seems to be that the grooving of the already damaged bone, still further interferes with its blood supply, and although some fresh bone forming elements are thrown out to make a weak union, they are not enough to bring about real solidification. The best operation to avoid this difficulty is, I feel sure, that suggested by Chutro about a year ago. It consists simply in cleaning one side of the bone fragments and inserting a wafer of periosteand superficial cortex removed from the tibia, between the bone and the periosterm. This is held in its place with cortex to cortex and periosteum to periosteum by simple cat gut stitches. This method interferes with bone nutrition in the least possible degree. It employs a thin transplant in which circulation is easily re-established. It will succeed in spite of considerable sepsis.

Surgery then in ununited fractures should aim first to establish simple contacts between refreshened ends. If this is impossible then in large bones whose nutrition is good use the strong graft in a groove in the cortex, but drill and cut as little as possible. In

the small bones or where nutrition is poor use the thin wafer overlay of Chutro.

All of these operations are subject to failure because of septic flare ups, no matter how long we wait. For this reason I am convinced the two stage method of operating should be used in all cases where there has been sepsis. At this first operation remove scar tissue and explore the field thoroughly. Close up tight. If no sepsis appears in ten days reopen the wound and do the bone operation. If sepsis does appear drain widely and freely and no harm is done. This two stage method will save many disappointments in operating or ununited fractures.

In conclusion:

1. Avoid delayed union by early accurate reduction.
2. Wait for very long periods before interfering surgically.
3. When surgery does become necessary do the simplest possible operation by the two stage method.

Discussion.

Dr. H. Winnett Orr of Lincoln, Nebraska, said that one point to be emphasized was that non-union would no doubt have occurred with much less frequency if treatment had included perfect immobilization and perfect position from the beginning; but, in seeing these fractures at any stage, the first thing was to try and secure immobilization, even after the opportunity for union might seem to have gone by. In the treatment of fractures following injury the question arose as to whether it was better to attempt to restore extremely traumatized parts to normal position, or to allow the inflammation to subside. Sir Robert Jones was emphatic in insisting upon securing return of parts as soon as possible to normal position. If this was not done, patients presented extraordinary difficulties later on. The problem then was whether to establish drainage first, or secure normal position, or both together. At Savenay all that was done was to try to secure position and immobilization and send the patients back to the States as fully protected as possible. One point was clearly shown, that it was necessary to abandon many of the procedures and kinds of apparatus in vogue. This principle should be carried into civil practice. By simplifying methods, young men without any previous experience in fracture, could be taught to be experts in handling of these injuries. Their success showed that very fine work could be accomplished by men who had but a few weeks training. Another point was important, and that was to maintain the full length of the femur even when a large portion of the bone was missing. In the long trying interval before operation, proper maintenance proved of great advantage. One point in regard to fractures of the humerus should be noted: With the long Thomas splint, there was often too much traction resulting in excessive length, and revision of the extremity had to be made by shortening up the upper arm one or two inches. Traction had gone on too long. The standard of work in the A. E. F. was raised by Colonel Goldthwaite's campaign. These methods should be carried into the instruction of students, and to the profession at large. In regard to apparatus: a committee should be appointed to revise text-books in regard to methods of splinting. Anyone who now consults text-books is left in a haze ,and very likely to choose an unsatisfactory method. If students could be taught a simple, practical group of methods.

of splinting, that could be applied to all fractures, under all circumstances, orthopedic teachers would have accomplished one of the most useful results to be obtained from our war experience.

Dr. DeForest P. Willard said that he was with Major Kidner during the first part of the overseas work. They were brought up on the same military surgical principles. He could heartily endorse the statements made in regard to treatment of ununited fractures. He believed that nature could do more for the bone than the doctor could. Until nature proved she could do nothing more, the doctor should stay out. Operative procedures should be avoided until absolutely necessary. The best help was afforded by proper fixation and immobilization. Cases had been sent home on account of sepsis, to wait for operation, and had come back later with absolutely solid union. One man who had lost two inches of bone in the tibia was sent home for 6 months, and came back with an absolutely solid autogenous graft of his own.

Another important point was the pre-operative care of these cases. Given a non union case which would need bone grafting, it must have the most careful pre-operative treatment, to insure the best ultimate function of the limb. Non-union was only one of the things that was wrong with that limb. Especially in the lower arm cases, there was great destruction of muscle tissue and loss of function: stiff fingers and wrists, and loss of elbow and shoulder motion, loss of pronation and supination. These should be most carefully treated. If one waited till after the insertion of the bone graft, one had lost the most valuable time for getting back motion and correcting deformity. All cases should have the benefit of early hydrotherapy, massage, and active and passive exercise. Tendon transplantation could be done early and the bone graft later. In loss of radius or ulna, the hand would tend to deviate to the side of the injury. That could be avoided by treating early by means of a short plaster splint with cuff across the hand, short enough not to interfere with massage of the fingers. The support should go half way up the arm.

In regard to the interval between time of healing of the war wounds and time of operation, some men advocated going in very early. In England, however, they did not operate for a year, but that would seem a little too long. Still, it was better to be on the safe side. The best method after a severe infection with streptococcus or gas bacillus, was the two-stage operation 6 months after injury. Then scar tissue should be excised and the ends of the bone cleaned up, taking cultures at the time of operation. With negative cultures it was safe to go in a few days after healing of the soft parts. The second operation was much easier and the chance of sepsis was decreased. In regard to the type of graft, small bones needed a small graft. Mechanical fixation of the radius or ulna by the graft was not necessary. The Chutro graft with an excess of periosteum, to aid blood supply, gave the best results. Cases had been seen in England and France where the large graft put into ulna or radius had held for three or four months and then absorbed, and the men came back with as bad a fracture as they had at the beginning. There was no doubt that no case should be considered as being one of non-union until nature had been given every chance; that where non-union was assured, the 2-stage operation gave the best results; that the autogenous bone graft gave the best chance of attaining solid union.

Dr. Z. B. Adams of Boston said that he thought the chief points had been emphasized, but there were one or two which it might be well to mention again, the first of which was that time was most important to give nature a chance. Things could be done to stimulate union of bone. Jones drew attention to the fact that hammering the site of the fracture at intervals of a week would stimulate union by causing local hyperemia. In regard to metal plates, everyone was agreed that treatment by metal plates was not the best way to treat delayed union. It might do a good deal of harm. In one case seen of plating in the arm bone, the man had a perfectly satisfactory arm for several years, at the end of seven years it was found that he had a slow low-grade osteomyelitis, caused by the plate. A standardized method of treatment was best in which the bones were

brought into line and held there, and function of the surrounding joints and nutrition of the muscles and soft parts was maintained. Such procedures would tend to limit the number of delayed non-unions.

Mr. Hey Groves of Bristol, England, who spoke by invitation, said that he had been introduced as delegate of the British Medical Association, to the American Medical Association. This was incorrect, he was delegate from the Royal College of Surgeons, and he felt so proud of the fact, that he wanted it mentioned. He was the youngest member, and probably selected because of the fact that his mind was still young enough to receive stimulation. He wished to speak on a great many points in this interesting question, and hoped that courtesy to a guest would not prevent the Association stopping him when he overstepped the time limits. Mr. Hey Groves said that he had been associated with Major Kidner at Shepherd's Bush Hospital, and he cordially agreed with him in some points, and as cordially protested against others. There were some important points in regard to the treatment of comminuted fractures that could not be passed over. Dr. Kidner's general remarks on this question were correct, that was, fragments should be left in position, but there was a difference in the interpretation of results. In fracture removal of the fragments was often undertaken as a primary step. The speaker said he was rather skeptical about the osteogenetic power of the periosteum. If comminuted fragments were immediately removed there was no trace found of young bone formation. If fragments were left in position for a certain length of time, three to four weeks, and then removed, there was seen a rather thin type of new bone which would have to be restored. If the fragments were left in for 6 to 8 weeks then there was formation of external callus or involucrum. Comminuted fragments were full of bone cells which were poured out upon the vascular portions of the periosteum. But in case of sepsis, the little bits of bone shown in Dr. Kidner's pictures, would never have the chance to do anything at all. In regard to fractures of the humerus and the femur. The two ends of the bone were always sclerosed and avascular, very often full of latent sepsis. The two stage operation was essential here. In operating the scar tissue was cleared off, and the two ends of bone cut off. These latter often gave a pure culture of B. coli or streptococci. It was well to cut off the bone ends very generously, because it was not more difficult to fill a gap of two inches than one inch. It was necessary to get cut raw sufaces of bone in contact by making a block or mortise cutting. The speaker said he was going to shock his audience. It was not enough to introduce raw surface of bone to raw surface and then leave it. It must be tied. In America metal was reserved to make dollars with. In some respects this was wrong. It was of the utmost value to put through bolts and screws of bone, ivory, metal or wire. Mr. Hey Grove said he felt he had got his audience against him, and that was a very stimulating feeling. In regard to the employment of plaster of Paris, it was undesirable after operation to put a limb in plaster of Paris and leave it for many months, but sometimes it had to be done and muscle function had to be restored later. The speaker said he felt the same thing about metallic suture. The less metal used the better, but when one had a fractured femur what was the sense of using a piece of kangaroo's tail to secure the fragments. One had either to leave it with a prayer, or use plaster. The catch phrase "metallic fixation means atrophy" had been overdone. One could only follow it up to a certain point. The point was this: a certain amount of absorption or atrophy did take place at the nuts, but that was only a preliminary stage of repair in normal fractures, and repair never began without osteoporosis before final osteosclerosis took place and formation of a tube. Absorption of calcium salts was not necessarily an evil. A well fitted bone might be securely lifted and kept in place by metallic suture or bone nail or screw. In the case of the femur one could take a very fine drill and make 8 or 10 drill holes in the axis of the bone until every one began to bleed. In this way one could tap the vascular and cellular resources of the bone, which would help in union. In regard to bone graft, Mr. Groves did not believe that one could prevent deformity by use of a plaster of Paris cast. The most one

could do was to minimize it. There was never a case in which deformity was frankly corrected, or over-corrected. In arm injuries, when there was a gap in the lower end of the radius and one had got to put in a bone graft, one could not put it in the position of the deformity; that would simply consolidate the deformity. One must restore the continuity of the bone at the same time that one corrected the deformity. It was well to cut off the solid ends of the bone quite generously to make sure of having thoroughly vital bone, the gap was measured and a little bit more allowed, then a piece was cut from the anterior crest of the tibia, about ¾ inch wide and ½ inch thick, amply provided with periosteum. He did not speak disrespectfully of the periosteum; it was a first-rate thing if one did not expect too much of it. The right use of it made all the difference between success and failure. The fascial covering of the tibialis anticus was taken, because it was a vascular membrane which readily made vascular and organic communication with the vascular ends of the bone. The periosteum had been drawn back from the ends of the bone, the grafts were tapered at the ends and one could then separate the ends of the radius and they would spring in when the graft was in place. The intermedullary fixation assumed a slightly curved line which gave it a bucket handle hold, necessary for pronation. It was permissible to split the fragment of the bed into which one was driving the big end of the graft, and then tie with wire sutures. The periosteum was then sewn over so that the graft was not naked but covered with a petticoat. The little niche formed was a bed for the young bone growth to take place. That graft was mechanically perfect and could not shift in a day or a month. One man was so pleased with his arm as the result of this operation that he climbed a wall and broke it again. Another man went and got married and had such a splendid honeymoon that he broke his arm again. It was well to put on a moulded splint which could be laced on, to afford protection, and by this method one was independent of very long plaster of Paris immobilization.

Dr. E. W. Ryerson of Chicago, Ill., said that his sympathy was with the officer who got married and broke his arm. He had noted a little inconsistency in the bone bridging method described by one of the speakers, who said he had cut away bone and brought the ends together without shortening! That was magic. He was interested in Dr. Kidner's methods of grafting, but some of these were still sub judice; one method would not work under all circumstances. The sub-medullary method of Mr. Groves was very useful, yet all knew how difficult it was to divide synostoses and get good results afterwards. Stiles had devised a good method for loss of pronation and supination, in ankylosis of the elbow. He removed a section of the ulna above the pronator quadratus, thus causing a non-union. A man without pronation and supination was in a hard position. One could make a false joint, but the arm would not be as strong as before, and not very good in hard labor, such as farming. If one did not wish to carry out the two stage operation, one could test the limb by active massage and physio-therapy beforehand; if there was no reaction, and if the scar was losing its red color, one could perform the operation at one sitting. Even if there were symptoms of infection, one could not keep the soldiers sitting in a hospital a year longer. It would be pretty hard for medical men to stay in the service long enough to do these late operations, but that was a question to be settled by the wise fathers in Washington. On the other hand, there was the two stage operation. It was difficult to persuade the soldier to submit to two operations in rapid succession, but most of them would stand for anything provided there was hope of success. More light was needed in cases of non-union of the femur with wide separation of the bones. He thought it was possible to put in Chutro grafts, although that was not as good as the intermedullary or inlaid graft, but could be put in earlier than two later.

Dr. John Ridlon of Chicago, said that there were two points to be considered in the question of bone grafts and plating bones. Grafts were put in to fill in a space and plates to fix the fractures while the bones were in contact. The bone graft for filling in space met the problem, but there was no necessity of bone

grafts for fixing fractures, which could be more readily fixed by metal plates. Metallic fixation of broken bones might hold them in a pus cavity in some instances until union took place. It was doubtful if bone inlays would unite in the presence of any considerable quantity of pus. Fractures could be fastened by metal attachments and even if suppuration occurred, union would take place and the metal could then be removed. One point did not seem to be fully clear in the minds of the speakers, and that was the reason for atrophy in these bones. The metal plate had been credited with all the bone atrophy. The bone atrophy which resulted in delayed union or non-union was due more to disuse than to any other factor.

Dr. Albert Freiberg of Cincinnati, said that there were a number of points, which, in spite of study were not very clearly understood. Foreign bodies, such as plates, frequently operated as a cause of non-union. Before the war many men had had the experience of seeing fractures fail to unite until removal of such plates. After removal of plates and subsequent fixation by splints, the fracture united. The relationship of infection to non-union was not yet perfectly understood. In his work at the Walter Reed Hospital, the speaker said he several times found non-union present in the presence of sequestra. These bits of bone were left in presumably because they had periosteal attachments and were supposed to act as osteogenetic centers. It was necessary only to remove these fragments and subsequent union took place. It was not advisable to perform a plastic operation too soon. Union could be given an ample opportunity to take place first.

Dr. Kidner said he fully agreed with Dr. Freiberg that metal plates were often a distinct cause of non-union, whether by chemical or mechanical action. Dr. Freiberg mentioned sequestra: that was a difficult problem to determine what were sequestra and what were viable bone fragments. When the X-ray showed small areas of dense bone lying in line with the fracture, of the type ordinarily considered sequestra, it would often be found that these fragments had some blood supply and took an active part in healing the fracture. Dr. Porter's remarks about the splitting operation were theoretically true, but in a great many cases after splitting, further atrophy went on and the graft lay loose in a completely atrophied lower fragment. A graft laid in contact with small lower fragments was much more likely to do good.

Dr. R. T. Taylor of Baltimore, said that there were two fundamental factors that could be agreed about: those were the question of alignment and circulation. If either were interfered with there would be failure and non-union. Scar tissue or muscle tissue causing mal-alignment, must be removed, and if it is necessary to secure alignment temporarily by some device, one had to use it. In recent cases seen of gun-shot wounds of the patella, which had been sutured and repaired, but by absorbable or metallic sutures, patients had made a misstep and the sutures had pulled out and fragments separated. A method was devised by Dr. Taylor, which approximated the fragments by chromic cat-gut or kangaroo tendon, putting in double mattress sutures on each side. An X was formed at the patella, by taking a strip from the tibia, cutting it in two, crossing it and mortising it together and inlaying, so that in future any strain would pull the two V's together and tighten them in their bed. A diagram of the inlay X was shown afterwards, also X-Rays of cases before and after bone grafting.

Dr. John L. Porter of Chicago, said that it was difficult to fix a bone graft into small atrophic fragments, as in the case of the radius with loss of substance. A perfect end of the lower fragment of the radius could be tapered off, but on account of the traction of the pronator quadriceps the end of the bone was tipped. He had found a method of attaching a bone graft to these small fragments, without sacrificing bone. The small fragment was split, and a piece taken from the tibia was chiselled and driven into the fragment, using this as a lever and dropping it in, in correct position. Thus one had a bone graft with sharply pointed end, which would allow of pulling the small fragment up into position.

Dr. Torrance Rugh of Philadelphia, said that the condition of sepsis had been considered the greatest factor in the present war, and all attention had been focussed on that. The individual factor had been lost sight of. Internal secretion has a most profound influence on bone proliferation. Many of these cases of delayed or non-union would be benefitted by treatment with thyroid or any of those glands which influence metabolism.

Mr. Hey Groves said he would like to add a word about bone plating. He had uttered a plea for the occasional use of metallic fixation. In the Lancet in 1914 he had stated that "the bone plate had led to the death of the patient or the sacrifice of the limb." He had made this aggressive statement to draw attention to this fact. If the American surgeons in 1918-19 had been content to learn by the work of the British, they would not have had to learn by bitter experience. The speaker said his cases showed 4.5 per cent. of cases of non-union in fractures. The shortening operation was applicable to the humerus. In the femur one could get one and a half inches compensation by tilting the pelvis, and one and a half inches by wearing a proper boot, therefore one should try to bring ends together if possible. In regard to the influence of the periosteum, that was a vexed question. The influence of MacEwen's work was admitted, but these views had been fully borne out by experiences of the war.

Dr. Frederick C. Kidner said that he had listened to Mr. Hey Groves with pleasure. He was a brilliant refutation of the idea that the mind of the English surgeon moved in ruts. His work also seemed to contradict the idea that the Englishman was patient and the American in a hurry. It would seem that the American workers were content to wait longer than were the British. It was true that there were fractures where metal plates, or similar attachments did help enormously, but almost all the metal junk put in had to come out later, and often it did interfere with bone proliferation and union. The question of length of bone had been mentioned. He had not enlarged upon that as it was a doubtful subject. It seemed that if fractures could only be brought into good contact by shortening, and if shortening did not interfere too seriously with function, then it should be done. In the humerus, radius, and ulna and some times in the femur, it might help in getting a useful result. Mention had been made of joint function; every fracture that it was possible to treat by fixation with simultaneous motion and manipulation of adjacent joints, should be so treated. Certain types of apparatus permitted motion with fixation, but fixation of the fracture must be secured at all costs. Periosteum was a very useful structure, it acted as a matrix which supplied nutrition. In the vast majority of cases it also carried a certain number of bone producing cells from the superficial layers of the cortex, which had true osteogenetic power. Dr. Ryerson spoke of the type of graft. It made comparatively little difference in the large bones which type were used, if properly placed, but in the small bones, any graft requiring much manipulation would interfere with nutrition of the damaged bone and delay union, rather than hasten it. The value of the Chutro graft lay in the fact that it did not interfere with the blood supply of badly damaged bone.

THE PEDAL GROUPS

BY WILLIAM JACKSON MERRILL, A.B., M.D., CAPTAIN M.C., U.S.A.,
PHILADELPHIA, PA.

Any divergent notion concerning the mechanics of the foot structures, as to the existence of arches in the true sense, challenges the views and theories of orthopædists and other members of the medical profession who have based their opinions upon various hypotheses defended by exponents of certain postulates formulated from an incomplete comprehension of statics and posture.

The majority of persons to whom the duty comes to analyze the altered conditions of posture of the foot structures, think first of the arches as the starting point of the trouble, especially if they have had but a limited experience in the treatment of the foot affections, and the first thought is to prescribe a prop for the arches. It would be better for mankind if the notion of arches had never been born.

The type of foot that shows an inward deviation at the ankle joint seems to be a serious problem to many, and it is all the more confusing to such persons when this condition is called "ankle valgus." Pronation means precisely an inward deviation at the ankle joint which permits of a rotation of the foot inward on its longitudinal axis. Valgus, according to the old conception of the term, denotes a combination of deviations. Why add mystifying terms to a foot that has simply tipped inward? If these conditions, also flaccid flat foot and other variations in the posture of foot structures, due to combined mechanical and physical defects, were analyzed from the point of view of anatomy and physiology, and the process of thought were from deep within the patient's constitution outward, rather than from without inward, to just below the skin, falling flat at the "arches," the problems would cease to be puzzling.

When one loses time considering whether the "anterior transverse arch" (the existence of which is purely imaginary) has "fallen" and experiments with methods of propping up this chimerical structure, as a rule he succeeds in making the trouble worse if, in the beginning, it were a little more than trivial.

The action of the foot in performing its functions in the process of walking consists of two phases: one period for the time the

heel is on the ground and the other from the time the heel leaves the ground until the thrust of the toes is completed. The behavior of the different structures in the two phases varies considerably. It is the purpose here to call attention to these variations rather than to discuss the mechanics and nature of the defects.

The greatest strain in the foot, whether its structures be in the normal or abnormal state, is during the act of walking, and not in standing. It is during the period in which the heel is off the ground, in the act of walking, that the true arch principal does not exist. As soon as the heel is raised from the ground, the mechanical principle embodied in the combined structures of the foot, change from the arch to the suspension principle. The percentage of strain at any given point is greatly increased by the discursion of a given part from its normal relationship with its reciprocating structures. The ratio of strain to the angle of deviation is indirect rather than direct. The change from the normal relationship of the several segments of the foot under the stress of weight bearing and other functions, varies widely in accordance with the relative superimposed weight, the muscle state, the mode of use of the feet, and the type of foot gear.

Analyzing the mechanical construction of the lateral pedal group, composed of the os calcis, cuboid, fourth and fifth metatarsal bones and their phalanges, and the fascia, tendons, and ligaments that support them, we find the following facts: the pull of the tendo-achillis on the os calcis tends to force the latter upward and backward and to cause it to rotate upward and backward on its transverse axis. These movements are prevented by the plantar ligaments, plantar fascia and to a lesser degree by the pressure of the ligaments on the sustentaculumtali. The pull transmitted through the os calcis to the plantar fascia and ligaments is applied to the distal ends of the metatarsal bones. These structures acting according to the bow-string principle with the bones of the foot form an arch. The lateral pedal group in most feet does not constitute an arch in the concentric sense, because these bones are in a practically straight line and the force of the ventral ligaments is not sufficient to maintain the principles of an arch in these bones. The points of weight bearing when the heel is on the ground (first phase) being the tuberosity of the os calcis, the tuberosity of the fifth metatarsal bone and the distal heads of the fourth and fifth metatarsal bones, for the lateral pedal group, make these structures

weight-bearing, more than stabilizing, elements, but when the heel is raised from the ground the structures of the lateral pedal group enter into the mechanism of the foot as suspension and stabilizing fundaments more than weight-bearing structures. Arches can only be considered as such, purely in the mechanics of weight-bearing in the foot, when the heel is on the ground. It is under this condition that the outer pedal group is a weight-bearing structure in the pressure stress sense. This pressure stress in the lateral pedal group is changed to a tensil stress, chiefly in the os calcis, when the heel is raised from the ground, and the only remaining concentric arch is practically the mesial pedal group. The forces which are applied to the astragalus to force it upward and forward in walking, arise in the tendo-archillis and the posterior muscles of plantar flexion of the foot.

When the heel is raised the superimposed weight of the body is transmitted through the tibia and fibula, astragalus, scaphoid, and the three cuneiform bones to the three inner metatarsal bones and the latter bear chiefly the weight of the body. The mesial pedal group is supported posteriorly by the suspended os calcis when the heel is raised in walking and anteriorly on the distal heads of the three inner metatarsal bones. There is a slight movement antero-posteriorly of the astragalus on the os calcis and this factor tends to make less stable the longitudinal arch of the foot when the heel is on the ground in weight-bearing.

In pronation, flattening, and valgus, and combinations of these conditions, the os calcis is moved outward and the axis of the pull of the tendo-achillis, instead of being in line with the tibia, is at an angle, and the stress thus applied forces the astragalus inward. Under these conditions the strain and disability vary indirectly with the deviation of the os calcis outward and with the stress.

During the process of walking, the heel is on the ground only about one-fourth or one-fifth of the period in which the foot is in the act of assisting in executing the stride, and the true concentric arch principle exists only for that period. As soon as the heel is raised from the ground, the structures of the outer pedal group of the foot are supports, mechanically, according to the suspension principle.

In analyzing and treating foot troubles, after the constitutional and local causes have been determined, the chief consideration in a given foot trouble should be applied to the period of time that the

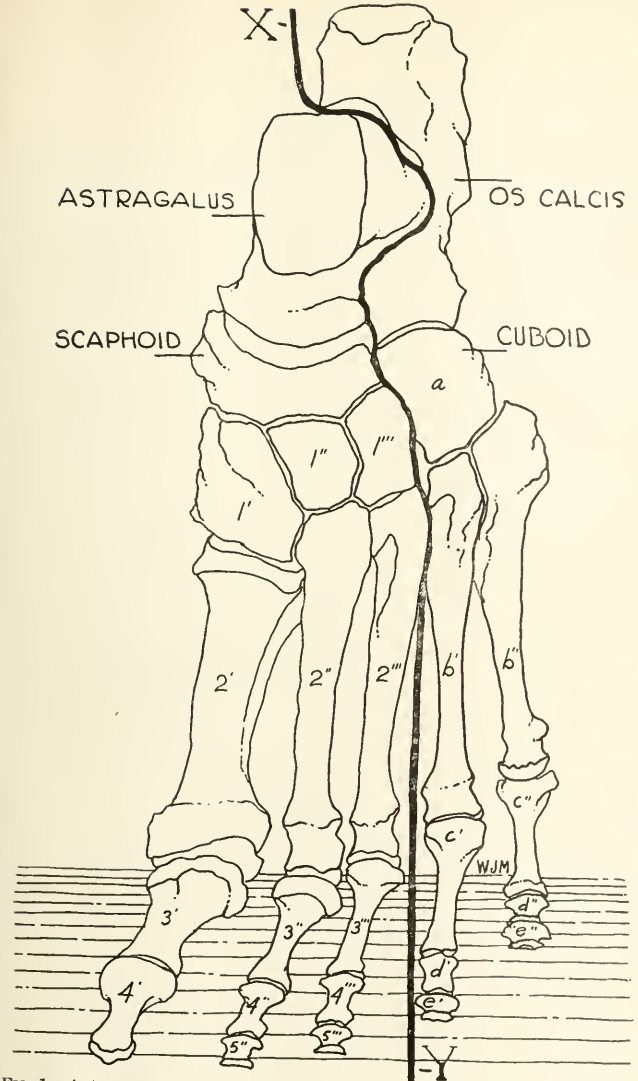


FIG. 1.—Antero-posterior view illustrating the relative distance that the 4th and 5th metatarsal heads are raised from the ground when the heel is raised in the act of walking.

The mesial pedal group consists of: Astragalus, Scaphoid, Cuneiform bones (1′, 1″, 1‴), the three inner metatarsal bones and their phalanges (2′, 2″, and 2‴, and 3′, 3″, and 3‴, etc.).

The lateral pedal group consists of the Os Calcis, Cuboid, 4th and 5th Metatarsal bones (b′ and b″), and their phalanges.

The line x-y denotes the line of *anatomical and mechanical cleavage* between the mesial and lateral pedal group.

weight of the body is borne by the foot when the heel is raised, and the behaviour of the foot structures under such conditions of stress and strain should be known.

Anatomically, mechanically and functionally the longitudinal arch is composed of the os calcis, astragalus, scaphoid, cuneiform bones and their metatarsal bones, when the heel is on the ground. Anatomically and mechanically the bones of the feet are divided into two groups, which may be called the Pedal Groups: the mesial includes the astragalus, scaphoid, cuneiform bones and their metatarsal bones and phalanges; the lateral is made up of the os calcis, cuboid, and its metatarsal bones and phalanges. The inner Pedal Group includes the three metatarsal segments, the first, second, and third, each being composed of a cuboid and a metatarsal bone and its phalanges. These metatarsal segments comprise the anterior portion of the longitudinal arch when the heel is raised from the ground, and form the most important part of the longitudinal arch when the heel is on the ground. The outer metatarsal segment, composed of the cuboid, the fourth and fifth metatarsal bones and their phalanges, is a stabilizing structure to a greater extent than it is a weight-bearing structure. When the foot structures and posture are normal, the os calcis and tuberosity of the fifth metatarsal bone are on the ground and bear weight with the distal heads of the five metatarsal bones proportionately as the line of weight bearing stress. When the heel is raised from the ground, the pressure stress of these bony structures is changed to a tensile stress, which is imparted to them through the tendo-achillis, the plantar ligaments, the long and short plantar flexors of the fourth and fifth toes, the plantar fascia, and the peronei tendons. Through the action of these tendons and ligaments, the lateral pedal group becomes a stabilizing structure. These structures, especially the os calcis, act as a lever in supporting the astragalus; moreover, when the heel is raised from the ground the weight of the body is transmitted, through the tibia and fibula, to the astragalus, to the scaphoid, and to the three inner metatarsal segments, the astragalus being supported by the os calcis in accordance with the true suspension principle. Figs 1 and 2. The amount of weight bearing rendered by the fourth and fifth metatarsal bones is produced by the plantar flexor muscles of the fourth and fifth toes and the fascia and ligaments. The chief amount of change from the normal, in flattening and pronation, takes place in the mesial pedal group.

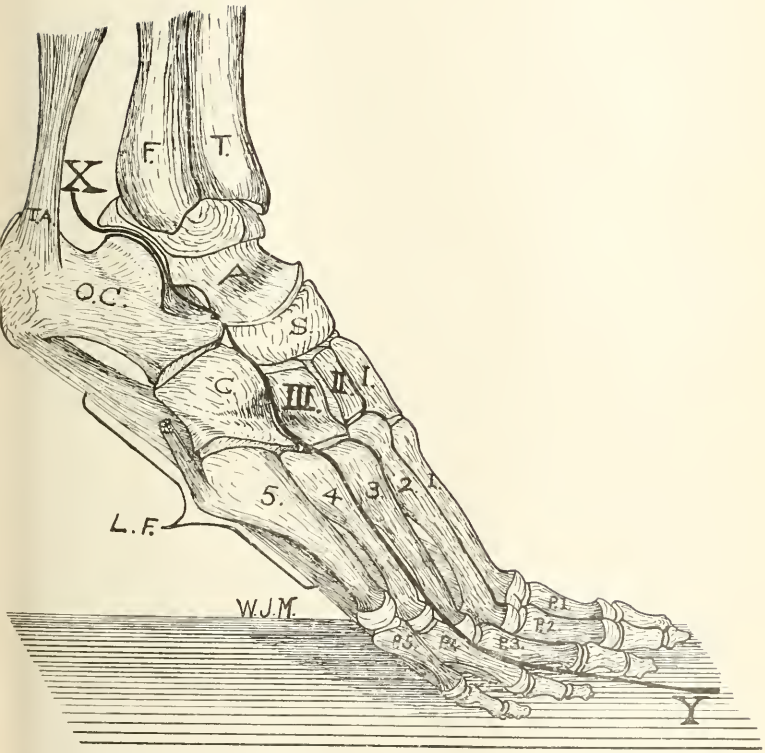


FIG. 2.—Lateral view of heel—raised as in Fig. 1—to illustrate the raising of the 4th and 5th metatarsal heads from the ground when the heel is raised. The line x-y denotes the *anatomical and mechanical cleavage* of the mesial and lateral pedal groups.

The proximal ends of the metatarsal bones move inward and downward when flattening or pronation, or both, takes place. Since the distal heads are fixed on the ground, this movement imparts *torsion strain* to the metatarsal and mid-tarsal structures. This strain produces pain which is usually located in the anterior metatarsal structures. The method of treatment of abnormalities, and the relief of the pain in the tarsal and metatarsal structures due to strain, must be based on these mechanical axioms. It is obvious then that methods of treatment must be applied to the weight-bearing structures in accordance with the mechanics of their discursions from the normal. In flat foot, the os calcis has moved forward and downward on its transverse axis, and inward on its vertical and longitudinal axes. The astragalus moves forward and downward, the anterior breadth of its trochlear surface is greater than the posterior breadth, the inter-malleolar space has a similar cuneiform shape, and this movement consequently increases the lateral play of the astragalus. The scaphoid moves downward and inward with the cuneiform bones and the proximal ends of the metatarsal bones. The downward and inward movement of the os calcis carries the cuboid downward and imparts a downward and inward torsion strain to the latter. By these combined movements, a torsion strain is imparted to all of the foot structures, but especially to the inner pedal group.

The restoration to the normal position of these weight-bearing structures must be accomplished by measures which will re-establish: power and tone to the muscles and ligaments, good posture of the weight bearing structures, correct use of the feet in performing their functions, and supports so applied that the fore foot will be adducted, the midtarsus moved outward and upward, the astragalus and os calcis moved outward and backward and the weight consequently thrown to the outer border of the foot. Supports must be combined with the shoe and stabilized with the sole and heel, or the attempt at correction will fail. It must not be forgotten that the support is only temporary, that constitutional causes must be eradicated, that local measures, such as massage, indicated applications, exercise, etc., must be employed, and that correct use of the feet in walking and standing must be practised.

H. AUGUSTUS WILSON, M. D., F. A. C. S.

DIED APRIL 16, 1919

An appreciation by Dr. R. W. Lovett of Boston. Read at the meeting of The American Orthopedic Association June, 1919.

Augustus Wilson died of uraemia after an illness of three days at his home in Philadelphia, on April 16th, 1919, and by his death orthopedic surgery lost one of its most representative men, and the American Orthopedic Association lost a devoted servant and a faithful friend. Born 65 years ago, he graduated in 1879 from Jefferson College and began medical teaching at once in the Philadelphia College of Anatomy. He taught later in the Philadelphia Polyclinic and in the Women's Medical College, and in 1904, he became clinical lecturer on orthopedic surgery in the Jefferson Medical School, later to become clinical professor, and in 1904 professor of that subject. He resigned his professorship and was made emeritus professor in 1918. A teaching record of some forty years is an exceptional record, and one of importance when that teaching, as in his case, was always sound and sane and painstaking. A great number of students pass through the hands of a man who teaches for forty years, and a widespread influence on the profession is exerted by such inspiring and honest teaching as that of Wilson. In this matter he laid the medical profession and orthopedic surgery under a heavy debt. He was connected first and last with many hospitals of the first class, a catalogue of which is not necessary. To these he rendered the devoted service which was characteristic of all that he did. From the time that he joined this association in 1891, until the time of his death, he was one of its most useful and influential members, and he served it in many capacities, as president, member of the executive committee, member of the publication committee, and in minor places. The association had few more regular attendants, and few men more conscientious in going to all of every session and doing what he could to make each session a success. I should say that the man's chief characteristics were earnestness, unselfishness, kind heartedness, and absolute devotion to a cause once undertaken. He was a man of ideals which he never sacrificed, his profession and his family filled his life, and he had few outside interests. He was a most indomitable worker and he had one agreeable trait, that of making the man with whom he talked think more highly of himself than he did before the conversation, for he seemed to look for the best that was in each man, and to dwell on that side of his relation to each one. I never knew him before we met in the association, but this relation as a co-worker with him in the publication committee led to an intimacy between us which lasted to the time of his death, and this intimacy led me to recognize in the man a rare unselfishness, a real idealism and a sincerity of purpose which may well serve as an example to any and all of us.

GWILYM G. DAVIS, A. M., M. D., L. L. D., M. R. C. S. (ENG.) F. A. C. S.

DIED JUNE 16, 1918.

An appreciation presented at the 1919 meeting of the American Orthopedic Association by J. Torrance Rugh, M. D., Philadelphia.

A short pause in the activities of this energetic society is taken to consider the loss of an Active Fellow who in the twenty-one years contributed thirty-four papers to the Transactions and was repeatedly chosen to fill official positions.

His charming personality, his scientific attainments, and his unselfish devotion to his profession resulted in his being adored by his patients, worshiped by his assistants and endeared him to those with whom he was brought in contact.

Dr. G. G. Davis became a Fellow of the American Orthopedic Association in 1897 and received many tokens of the high esteem in which he was held by the Fellows. At the time of his sudden death, June 16, 1918, he was the newly elected treasurer. He had held the same position from 1907 to 1913, retiring to become president in 1913. He was second vice-president in 1901 and also in 1903.

Dr. Davis was born in Altoona, Pa., July 20, 1857. His father was Thomas Rees Davis and his mother Catherine Fosselman Davis. He was graduated from the Central High School as A. B. in 1876 and five years later A. M. was conferred upon him. In 1879 he graduated in the Medical Department of the University of Pennsylvania and in 1881 he received the degree M. D. in the University of Goettingen, Germany; in 1880 M. R. C. S. (England) and L. L. D. from Lafayette in 1911.

In the early years of his practice of medicine he was largely known as a general surgeon because of his extensive and skillful work as surgeon to the German Hospital and senior surgeon to St. Joseph's Hospital and surgeon to the Episcopal Hospital. As Associate Professor of Applied Anatomy in the University of Pennsylvania he acquired that intimate knowledge of anatomy that made his surgical procedures definite and certain.

His interest in orthopedic surgery was acquired through his connection with the Philadelphia Orthopedic Hospital and became deeper through his Fellowship in the A. O. A. Upon returning from one of the annual meetings of the A. O. A., Dr. Davis determined to resign all hospital positions except those that were entirely orthopedic and devote all his energies to orthopedic surgery. From this time on his contributions to orthopedic literature became more frequent and of greater scientific value. His book on Applied Anatomy, published in 1910, attracted great scientific attention.

His private practice became so large as to necessitate assistance, which he secured by engaging Dr. F. D. Dickson. When Dr. Dickson accepted the call

to go to Kansas City to become Associate Professor of orthopedic surgery in the University of Kansas, Dr. DeForest Willard took his place as Dr. Davis' associate. This continued most happily until Willard entered the U. S. Medical Service.

The winter of 1916-17 was a particularly arduous one as his position on the Advisory Orthopedic Commission to the Surgeon General demanded great additional work in instruction in military orthopedic surgery at the University of Pennsylvania. His undergraduate teaching, his many hospital positions, and his private practice gave him no time for relaxation. He sought the privacy of his camp in Maine but, alas, pneumonia developed and, being far from medical attendance or nursing, he succumbed on June 16, 1918.

Dr. Davis was elected Professor of Orthopedic Surgery in the Medical Department of the University of Pennsylvania 1911. He was Chief Surgeon to the Widener Memorial School. He was a Fellow of the American Orthopedic Association; Fellow of the Philadelphia Academy of Surgery; The Philadelphia College of Physicians; the American Medical Association; The Philadelphia Pediatric Society. He was a member of the Iota Chapter Phi Beta Psi fraternity and also of the Alpha Mu Pi Omega of the Medical fraternity. He was a member of the University Club and the Art Club. Dr. Davis was a bachelor.

His contributions to the American Orthopedic Association were:

1898. The Operative Treatment of Webbed Fingers.
A Brace for Cases of Lateral Curvature of the Spine.
A Brace for Pott's Disease of Spine.
Head Support for High Pott's Disease.

1899. The Technique of Osteotomy, with the Description of a New Osteoclast.
A Brace for the Treatment of Stiffness of the Elbow.
Instruments for the Formation of a New Acetabulum in Congenital Luxation of the Hip.

1900. A Brace for Lateral Curvature of the Spine.
An Operation for Ununited Intracapsular Fracture of the Neck of Femur.
A Splint for the Treatment of Equino-varus.

1901. A Brace for Antero-posterior Curvature of the Spine.
A Flexible Curve and a Flat-foot Plate.

1902. Lateral Deviation of the Spine.
An Apparatus for Paralysis of the Extensors of the Hand and Fingers.

1904. A Forcible Reposition of Congenital Luxation of the Hip.
Club Foot Stretcher.
The Treatment of Lateral Curvature of the Spine.

1905. An Apparatus for Making Passive Motion of the Elbow.
Multiple Cancellous Exostosis.

1907. A Method of Reduction of Congenital Luxation of the Hip by Manipulation.
Resection of the Knee with the Object of Obtaining a Movable Joint.

1908. An Operative Treatment of Intracapsular Fracture of the Neck of the Femur.
A Brace for the Retention of Congenital Luxation of the Hip after Reduction.
A Sling for Head Extension.

1911. An Operation for the Treatment of Anterior Dislocation of the Head of the Radius.
A Rolling Bench for Use After the Reduction of Congenital Luxation of Hips.
The Treatment of Paralytic Outward Rotation of the Foot.

1912. The Structure and Mechanism of the Human Joints in Health, Disease and Injury.
Proceedings of the Fourth Italian Orthopedic Congress.

1913. The Treatment of Hollow Foot (Pes Cavus).

1914. The President's Address: The Education of Crippled Children.

1915. Local Treatment of Painful Nontubercular Joints.

1916. Stability of the Lower Extremity in Paralytics.
Treatment of Paralysis Following Poliomyelitis.

1917. Lumbo-sacral Pains Considered Anatomically.

Current Orthopaedic Literature

Osteomyelitis. By F. H. Baetjer, M. D., Baltimore, Md. Maj. Med. Res. Corps, U. S. A. *The American Journal of Roentgenology.* Vol. VI, (New Series June, 1919. No. 6.

In a normal long bone we have a medullary canal containing the blood supply, nerves, lymph, vessels and marrow fat. Then we have the dense hard bone surrounding this which we call the cortex, this, in turn, being covered by a fibrous sheath, the periosteum; and at each end of the bone we have the joint surface, namely, a cartilaginous covering. Any one or all of these structures may be involved in an inflammatory process. When the periosteum is involved we have a periostitis; when the infection is confined to the cortex we have an osteitis; an infection of the medullary canal is a myelitis. The combination of diseased cortex and medullary canal we speak of as an osteomyelitis.

While the pyogenic factor may vary in bone infection, the process is the same, varying only as to the severity and duration of the infection. In a general way we may speak of four portals of entry:

1. Hematogenous or lymphoid in origin.
2. Infection lodging beneath the periosteum.
3. Arising in the joint.
4. Direct inoculation, as in wounds and compound fractures.

In the first group, the blood or lymph supply carries the infection through the nutrient canal into the medullary portion of the bone; and since this is filled with the soft marrow fat, the infection may spread easily and rapidly up and down the medullary canal.

When the infection lodges beneath the periosteum we have it and the bony cortex involved. Since the cortex is quite dense, the infection is more or less limited and does not tend to spread; consequently in this type the medullary canal is not often involved, but we have an extensive periostitis and osteitis.

When the infection starts in the joint we have an extensive destruction of both articulating surfaces, and finally the disease breaks through one of the cartilaginous surfaces and destroys to a more or less degree the head of the bone, where cancellous bone is present; and here again the infection extends but slowly into the medullary canal proper. In compound fractions the infection is carried directly to the medullary canal and raw exposed bony surfaces so that periosteum, cortex and medullary canal may be involved simultaneously.

The only two changes that take place are bone destruction and bone reproduction. It is the variation in these two processes which determines the diagnosis. Normal bone is pierced by numerous small Haversian canals which are in direct connection with the medullary canal. An infection that starts in the medullary canal not only extends up and down, but also into the Haversian canals. If the infection is virulent there is evidence of bone destruction, confined at first to the Haversian canals, and finally by extending down these canals, the infection will completely surround a portion of bone, thus devitalizing it, with the formation of a sequestrum. If the infection is virulent, this

takes place rapidly and the most marked changes are those of bone destruction with but little new bone formation. New bone formation is a repair process and does not take place until nature is getting the mastery of the infection. In the very early stages of even a virulent bone infection the bone may be perfectly normal in appearance upon the roentgen-ray plate, but at operation one finds the little canals that traverse the bony structure completely filled with pus. No bone destruction has as yet taken place and consequently the roentgen-ray plate will be negative. Such a case examined a few days later will show beginning destruction.

An acute osteomyelitis gives the following picture upon a roentgen-ray plate. The infection, having lodged in the medullary cavity, takes the path of least resistance and extends along the medullary cavity resulting in vacuolated spaces represented by areas of lessened density. The infection now spreads to the bony cortex and travels irregularly by means of little bony canals producing areas of bone destruction with normal bone in between, and eventually these areas of normal bone will become cut off and form sequestra. This is an important point of differential diagnosis, because every pathological process in bone must be viewed as a possible malignancy until proved otherwise. Malignancy in long bones starts from one central point and radiates equally in all directions, absorbing the bone as the growth advances, but never appears as separate areas with normal bone in between. The osteomyelitis infection will finally pierce the cortex in one or more places, leaving areas of normal cortex in between.

With the piercing of the cortex and the acquired resistance of the tissues, nature now attempts to limit the destructive process, and this is done by building up a new bony wall at the edge of the infection. To produce bone reaction there must be a stimulation, and the point of stimulation is always at the point where the infection stops and the normal bone begins. The result of this will be that the new bone laid down will follow the edge of the infection. This gives a varied picture, as the destruction will determine where the new bone will be laid down.

The deposit of periosteal bone will frequently be sufficiently great to give the appearance of expansion of the bone. Close inspection will reveal that the apparent expansion is in reality due to deposition of bone on the outside. This is an important point, as benign growths of the bone, such as cysts and osteochondromata invariably expand the cortex, while osteomyelitis does not.

The predominating feature in acute osteomyelitis is bone destruction with but little new bone production. In chronic osteomyelitis the conditions are exactly reversed. There is excessive bone reproduction with a few small areas of destruction. The entire bone is thickened, frequently to such an extent that the medullary cavity seems to be completely obliterated. The bone is often irregular in shape and thickened, due to extensive deposition of periosteal bone upon the cortex. In the bone there may be small areas due to little focal spots of infection. The following points must always be carefully noted:

1. The place where the infection starts.
2. The character of the destructive process.
3. The path of extension, that is, spreading equally in all directions or following the path of least resistance.

4. The character and situation of new bone production.

5. The condition of the cortex, whether it is intact, destroyed as a whole or pierced by sinuses, expanded or not.

In luetic osteomyelitis the lesions are generally observed in more than one bone and the clinical picture does not coincide with that given by the roentgen-ray. In lues the plate may show an apparently very acute osteomyelitis, evidenced by extensive destruction, the entire bone being involved, yet there will be but few clinical symptoms.—*Leo C. Donnelly, Detroit.*

Fractures of the Femur. A critical analysis of 131 cases of fracture of the femur, treated at the American Red Cross Hospital, No. 2, Paris. By Kenneth Bulkley, M. D. Major, M. C., U. S. A.: formerly chief of surgical service, American Red Cross Military Hospital, No. 2, Paris, France, and Donald B. Sinclair, M. D. Captain, M. C., U. S. A.

It is the object of this paper to analyze statistically 131 consecutive cases of fracture of the femur treated in the American Red Cross Military Hospital No. 2 at Paris.

1. A compound fracture of the femur should be operated upon and held for a month, or immediately transported without operation to a hospital where definite treatment can be carried out. It is an injury of war whose mortality rate is high and whose late results are very often crippling. It is an injury to which a sufficient amount of attention is not paid, possibly because often associated at first with relatively small wounds which to the unpracticed eye do not forbode serious results. But it is from these wounds, no matter how small, that the danger arises. Closed fractures of the femur are not of particular danger. Given an associated local wound of the soft parts, and the prognosis becomes immediately worse. And given a combination of the two with an inexperienced surgeon doing inexperienced surgery and an inexperienced "triage" officer indiscriminately evacuating the cases, and the prognosis becomes distinctly bad. We are of the opinion that these cases should either be operated upon and held at an advanced hospital for at least a month, or else given priority in transportation and immediate evacuation to a hospital in the rear which can be reached in less than 24 hours after injury and in which the patient can be held for at least 4 weeks.

2. The chief danger lies in infection, gas gangrene in the early weeks and streptococcus in the later weeks. Both can be best combated by early, adequate, and radical surgery.

3. Bullet fractures are practically as dangerous as are those by shell fragments. The occasional bullet wound may be observed without operation, the shell wound never.

4. Those fractures splitting into the hip—and knee—joints are infinitely more dangerous than those involving only the intermediate portion of the bone. Those involving the hip should probably always be amputated and then disarticulated. The majority of those involving the knee will need resection or amputation.

5. The primary operative procedure should be radical to the point of ap-

parent brutality. We have never seen too large an incision. We have seen many pitifully inadequate ones.

6. Amputation should be done oftener and earlier. Too many attempts are made with disastrous effects as to life to save worthless limbs.

7. The ideal form of traction is skeletal, and this form of traction is practically without danger. Femoral traction is superior to tibial traction.

8. If more care were paid to operative treatment, less would be heard of the chemical treatment of wounds.—*Leo C. Donnelly, Detroit.*

The Influence of the War Upon the Development of Surgery, by Jos. A. Blake, M. D., of New York, Director of the American Red Cross Hospital, No. 2, Paris, France. *Ann. of Surg.* Vol. LXIX. May, 1919. No. 5.

There has been little of new in the knowledge we have obtained. There has been a confirmation of principles already known, and the progress that has been achieved has been principally in stabilizing treatment rather than in making discoveries. There has been no development to change the underlying principles of wound treatment as recognized and practiced before the war. This, in view of the enormous amount of material offered by the war, might be deemed an admission of failure; but when we reflect that the processes of repair in all wounds, no matter what their cause, are essentially alike, and that these processes have been studied for years, there is little ground for disappointment.

At the outset of the war military surgeons assumed that the great majority of wounds would result from small arms, i. e., rifle bullets, and that the casualties from high explosives such as shells, bombs and grenades, would be in minority. It was also thought that rifle bullets would produce clean, neat perforations such as might be made by a large knitting needle. There was no conception of the fact that the full-jacketted bullet could so often cause bursting and shattering effects. Consequently the dictum was that there would be few operations and that only small dressings would be needed; with the result that inadequate provision was made. When the avalanche of wounded descended, with lesions of indescribable magnitude, and laceration and mostly containing foreign and infectious material, a demand naturally arose from the overwhelmed surgeons for some means, capable of application by no matter what attendant, to combat the frightful infections which ensued. Thus recourse was had to antiseptics, and the antiseptic area was revived. Our old friends reappeared, phenol, Labarraque's solution, iodoform, the metallic salts and alkaloids, as well as the aromatics of the ancients. Perhaps I should not say reappeared, for they were always with us; rather they became dominant. And because they became dominant I feel justified in saying that the early surgery of the war was characterized by retrogression rather than progression.

The principle that well-nourished tissues can withstand and overcome infection, while, on the other hand, tissues bruised and deprived of their circulation not only cannot destroy bacteria but become actual culture media favoring the development of infection, although perfectly well recognized and understood before the war, was often overlooked and forgotten.

War wounds, particularly those caused by artillery, possess all the conditions which promote infection; the structures are torn and disrupted, masses

of tissue may be detached and the projectiles frequently entrain clothing laden with germs.

The treatment of these wounds may be said to have passed through three stages during the war. The first stage was that of debridement: the wound was laid open, the foreign materials removed and the tissues left to eliminate by natural processes those portions which could not live. In order to prevent and combat the fulminating infections resulting from the favorable conditions for bacterial growth, various antiseptics were used, some of which acted directly against the bacteria while others, by a sort of embalming process, rendered the destroyed tissues unfit for bacterial food. The evolution of the wound was characterized by prolonged elimination and suppuration.

The second stage of treatment was that in which substances, such as the hypochlorites were used to dissolve the destroyed tissues and thereby hasten their elimination. Of these the most commonly used in France was Dakin's solution, which was applied throughout the wound by Carrel's admirable method of intermittent flushing. The essential value of the hypochlorites lies in their solvent properties, which, by getting rid of the pabulum for the bacteria, permit the tissues to sterilize themselves. This treatment finds its chief indication for those wounds to which the complete operative treatment about to be described cannot be applied.

The third stage might be said to have actually commenced early in the war, but it can hardly be stated to have become generalized before the spring of 1917. It might well be called the stage of rational treatment, for it was based upon the principles already mentioned, namely, that well-nourished tissues can withstand and eliminate infection. Although this principle was well recognized before 1914, it remained to be proved that it was possible, operating under the unfavorable conditions of war surgery, to systematically convert wounds from hotbeds of infection into simple lesions healing immediately by first intention. It is particularly due to the excellent results obtained and reported by the French surgeons, especially Lemaitre, that this treatment became generalized. It consists in paring (epluchage) the surface of the wound, removing all devitalized tissue and foreign materials and closing it immediately, or if for certain reasons this did not seem practicable, leaving the closure to a later date. This rational treatment has not only been extremely successful, but it has saved an enormous amount of time as well as expensive dressing materials.

Although the war has thrown practically no new light on the ordinary bacteria of suppuration, viz., streptococci and straphylococci, much has been learned about the organisms producing gas gangrene. It is interesting to note that the treatment of this terrible disease in the early part of the war was also entirely directed against the infecting organisms, while later it chiefly consisted in removing the conditions favorable to their growth. The bacteria producing gas gangrene all belong to the group known as anaerobes, because they thrive best in the absence of oxygen. A common treatment early in the war was to inject oxygen gas into and about the infected tissues; which did not do more than increase the gaseous distention and thus produce more pressure upon the already anaemic tissues. Another treatment was to make multiple incisions in the subcutaneous tissues in order to let the gas escape. This might have done good if the gas had formed in these tissues, but the gas there was in-

nocuous. It was not until Kenneth Taylor, working in the Robert Walton Goelet Research Laboratory (then at the American Ambulance at Neuilly), proved that gas gangrene was essentially a disease of muscle tissue—not of healthy but of devitalized muscle—that the treatment was put on rational basis. It then became simple: early excision of all torn and devitalized muscle prevented the development of the diseases, and, when the symptoms had already appeared, removal in their entirety of the muscles involved usually stopped it.

With reference to tetanus, the prophylactic value of the antitoxin was proved, and its use became mandatory in the armies of all the nations instead of optional as had been the case in some. Until then, hundreds of lives were lost because of this lack of appreciation of its value. A profound study of tetanus was carried on during the war, especially in the British army. It was found that the protection afforded by the antitoxin could not be depended upon to last more than from twelve to fourteen days. Thus the occurrence of what is called "late tetanus" was explained, and at the same time its prophylactic treatment was indicated. Studies of the bacterial flora of chronically suppurating wounds show that the tetanus bacillus persists for a long time, especially in and about the dead bone so commonly present in gunshot fractures. The quiescent germs are apparently innocuous, the system of the individual being protected by the wall of granulation tissue lining the wound. If this living wall be broken down, whether by an operation or by rough handling of a fracture, absorption of toxin at once occurs, and, the protection of the original dose of antitoxin having ceased, tetanus ensues. The remedy is evident. Antitoxin must be readministered before any intervention which might destroy the natural barrier of the granulating wound.

Shock is characterized by a progressive depression of the vital forces as evidenced by weakness of the systemic and cardiac muscles, lowering of bodily temperature and finally, death. Hemorrhage causes similar symptoms, and hastens the development of shock; yet pure surgical shock may exist without hemorrhage. It is largely through the investigations of Cannon during the war that a working hypothesis has been reached which affords a reasonable explanation of the phenomena attending shock and at the same time a basis of its rational treatment. Cannon's hypothesis is, that shock is due to a diminution in the normal alkalinity of the blood caused not only by deficient oxidation, but more than probably by absorption of acid substances produced by the catalysis (i. e., chemical breaking down) of injured muscle tissue. Anything which contributes to deficient oxidation, such as the loss of red corpuscles, (hemorrhage) or the reduction of body heat, increases acidosis and shock. And as shock produces cardiac weakness and lowering of blood-pressure (resulting in sluggish circulation and therefore in deficient oxidation), a vicious circle is quickly established and the victim is doomed unless the chain can be broken. It has been found that if external heat be applied to the body, shock may be prevented or even arrested; but if the normal alkalinity of the blood has already undergone a certain diminution, fresh normal blood must be supplied by transfusion in order to restore the alkalinity and increase the blood-pressure and oxygen carriers. Infusion of alkalines are not altogether satisfactory. By transfusion, the patient, having been temporarily resuscitated, is enabled to withstand the operation necessary to remove the crushed and torn muscle

tissues, which, if allowed to remain, would again bring about the condition of shock and in any case lead to serious infection.

The technic of blood transfusion was so perfected and simplified during the war as to make it far less dangerous, thus extending its use and its value as a therapeutic procedure. One of the chief improvements, and one that might well be adopted for any civil hospital, was the classifying of donors among the personnel, so that blood suitable for any case could be immediately available without having to lose time in finding a donor with blood of the same type as that of the patient.

Much study was given to the effects of the different anaesthetics upon patients suffering from shock. Evidence was obtained by questionnaires sent to all the hospitals, and from discussions in the various meetings held in Paris and elsewhere. The consensus of opinion, which agreed with the laboratory findings, was that all the common general anaesthetics: ether, chloroform, ethyl chloride and nitrous oxide were harmful, but that nitrous oxide with oxygen was by far the least dangerous. Although the harmfulness of general anaesthetics was admitted, their replacement by local or regional anaesthetics, except to a limited extent, was not considered practicable or justifiable, as the use of the latter is not devoid of danger. The superiority of nitrous oxide given with oxygen is undoubtedly due to the latter, for by this means the oxygen of the blood is kept at a high point, thus obviating the danger arising from insufficient oxidation.

During the war, considerable advances were made in the surgery of the regions, particularly the chest. Comparatively little progress was made in abdominal surgery. As regards the nervous system, there were certain improvements in technic and many observations of great value, especially as to the prognosis of certain injuries.

In the surgery of the jaw and face the large amount of material afforded an unprecedented opportunity for the artistic and imaginative surgeon; and some of them developed much skill and ingenuity in overcoming frightful deformities and in bridging dental defects. In this work there were not a few transplants and bone grafts, and future observations as to the permanency and the assumption of new function by these grafts will be of great scientific value.

The surgery of the chest has always possessed a charm for the adventurous surgeon, involving as it does that of the heart and lungs, the most obviously vital organs in the body. An operation on these moving structures will never fail to thrill the most indifferent and cold-blooded surgeon. Before the war the high mortality resulting from intervention for conditions which were then considered to be sufficiently serious to justify operative treatment, impressed surgeons with the idea that operations upon the chest were excessivly dangerous. There were an enormous number of chest wounds of all descriptions during the war, with abundant opportunity to observe both their immediate effects and more remote ones, such as those produced by infection. One of the most striking observations was in regard to wounds opening the pleural cavity—the so-called sucking wounds. It was noticed that with such a wound a man got along fairly well for a short time and then rapidly went into shock and died. The reason was a lack of oxidation due to inadequacy of respiration. If the admission of air through the wound were stopped, these cases did as well as

those with non-sucking wounds. It became the rule to close such wounds as soon as possible even if they were only provisionally sewn together and had to be operated on and re-closed later. It was found that if shock could thus be prevented, the patient would subsequently withstand a formal operation in the course of which the wound of the chest wall could be excised and enlarged, the lung withdrawn if necessary, the wound in the latter also excised and sutured, and the chest finally closed. Closure of the chest, if only for a day or two to enable the vital functions to become re-adjusted was found to be imperative. Naturally under these conditions, it was of extreme importance that infection should be prevented, and it was therefore necessary to methodically remove the foreign bodies, torn and devitalized tissues, and, more particularly, fragments of ribs, which were found frequently to provoke infection. It was seen that extensive exposure and handling of the lungs was possible, and our pre-war ideas as to the dangers of thoracic surgery became greatly modified. Much was also learned in regard to treatment of infections of the pleural cavities, including the empyemata caused by pneumonia as well as those due to wounds.

Most surgeons in peace time are not particularly interested in fractures. In the first place, they do not occur in large numbers except in great factory or mining centers, and they do not as a rule appeal to the operating surgeon because they occupy beds for long periods and do not require the particular skill he possesses, or imagines he possesses, but a more purely mechanical one. At the outbreak of war there was a regrettable lack of knowledge as to the treatment of fractures. There was no authoritative work or report available on the treatment of war fractures, and what we know now may be fairly said to have been almost entirely acquired during the war. This would be unbelievable were it not for the fact that the war fracture differs greatly from the civil fracture in that it is caused by the direct action of a missile while the civil fracture is usually the result of an indirect bending or torsional force. The war fracture is open to infection, the bone is smashed by the projectile, fragments of bone are often detached and driven through the tissues so that they actually form secondary missiles; foreign bodies, often loaded with infectious material, lie in or are disseminated amongst the fragments; the soft parts are lacerated, even pulpified; in short the conditions are all favorable for the severest types of infection. Consequently the surgeon, in treating a war fracture, not only has to keep the fragments of bone in proper position but has also to contend with the worst forms of infection. In order that we may understand the difficulties he has to meet, let us consider what an infection of a fracture means. In addition to the immediate danger to life from sepsis it causes death, or necrosis of the fragments and ends of bone, the amount of necrosis usually depending upon the extent of interference with their blood supply produced by the injury. These dead pieces and ends prolong infection and hinder the processes of repair and union, and have to be removed by operation. If the operations for their removal are not properly timed, or executed, more bone may die or other complications follow. There is always a tendency on the part of the soft tissues to close too rapidly about the dead bone, confining suppuration and thereby causing abscesses to form which often burrow up or down the limb. In short, the clinical course of an infected war fracture is at first a severe infection immediately endangering life, and afterwards a sequence of flares of

suppuration of greater or less danger. The gravity of these infectious processes can be greatly modified by skill and proper treatment.

At the outbreak of the war immobilization was the cardinal principle in the treatment.

In order that this should be perfect, the rules, as laid down in the textbooks, required that the articulations on each side of the fracture should also be immobilized. Treatment throughout the early part of the war was consecrated to the principle of immobilization. The limbs and if necessary the body, were encased in plaster of Paris, windows being cut or bridges of metal being made so as to afford access to the wounds for dressing purposes. What happened? As infection developed swelling occurred, and the plaster casts had to be removed, split, or cut away. When this was not done soon enough, gangrene and loss of life were not uncommon results. When it was possible to keep the plaster casts on, wasting of the limb from disuse made the cast too large and they no longer fulfilled their purpose. Pressure was exerted in spots, causing sores; and filth accumulated beneath them. In some cases pneumonia developed on account of the fixation of the patient in a recumbent position. And if life and limb were preserved, what result was arrived at after this period of torture? In the best hands, as to union it was fair, although there was generally some shortening; as to function it was, almost without exception, lamentable, the joints were stiffened and the muscles wasted. In fractures of the thigh the results reported by some of the best clincs for the first year of the war show that less than two per cent. were fit to be returned to any kind of duty.

The improvement in treatment has been due to the discarding of the old precepts as to immobilization by fixation and the substitution of entirely different principles. The underlying physiological principle may be said to be that of the preservation of function.

The chief mechanical principle involved is that of traction. If traction be made on a broken limb in the direction of the axis of the proximal fragment of the broken bone when in the position of rest, no harmful angulation at the site of the fracture will occur. By position of rest we mean the position occupied when no forces are acting on the fragment other than those produced by the muscles to it. Very little external force (i. e., acting from without) is sufficient to materially influence this position. If a slight restraining external force be provided, considerable latitude of motion of the joint of which the fragment forms a part may take place without changing the position of the fragment. Traction being applied, the confining force provided by the stretched muscles is usually sufficient to furnish the slight external force necessary to prevent motion, and traction in the proper direction may be expected to permit a considerable latitude of motion in the contiguous joints without changing the relative position of the fragments. Traction overcomes the tendency to overlapping and shortening. With traction applied in the proper direction, the bending motion, i. e., angulation, at the site of fracture which may occur in the early days of the injury, is harmless, and the commencing union rapidly affords the slight restraining force necessary to maintain the relative position of the fragments.

It is obvious that if the direction of traction departs too far from that of the axis of the proximal fragment when in the position of rest, angulation will

result at the fracture. We cannot overcome this danger by fixation unless it be complete and the joints on both sides of the fracture be immobilized; for, if we fix one side only, the danger is increased. If there be freedom of play on both sides so that the parts on one side are able to follow any motion of those on the other, the danger is eliminated. This freedom of play is accomplished by suspension and by removing the point from which traction is made to the farthest distance possible from the site of fracture. The point at which traction is made should be, if possible, on the distal fragment itself, so that traction does not have to be made thru the joint distal to the fracture, thereby immobilizing them.

Although nothing new in regard to the operative treatment of fractures has been discovered, we have gained great experience in determining the best treatment to follow. Internal fixation of compound fractures by screws, plates, bands, or wires has been proved to be bad practice and unnecessary. The tendency at one time was towards the complete excision of all the small fragments in order to prevent infection and the continual suppuration which generally occurs when all the fragments are allowed to remain. Many cases of delayed or total lack of union followed complete excision, and the present practice is a conservative resection of enough bone to remove contamination and to permit drainage, while at the same time maintaining continuity of the fragments.

The last stage the author speaks of in the treatment of fractures is actually the first, and is the splinting for transport from the battlefield. The inadequate methods employed in this work was one of the cruellest features of the early part of the war. It was not uncommon for the wounded to be carried from the field with limbs swinging from the point of fracture, and the jagged fragments tearing and lacerating the tissues. The progress realized later was enormous, and here again was achieved by the use of traction, applied chiefly by means of the Thomas splint. This splint, used by the English orthopaedist, Thomas, over fifty years ago, largely as an ambulatory splint for tuberculous affections of the knee, has, with slight modifications in size and form, been of inestimable service, both for transportation and treatment. With two sizes of this splint nearly all fractures of both upper and lower limbs may be transported and treated with success. It is simple and cheap as far as construction is concerned, but it requires considerable skill in handling. For transport its application is governed by definite and simple rules. It was found that the enlisted men quickly became proficient in the application of this splint and were therefore able to splint the wounded where they fell. The latter were thus removed from the battlefield without suffering, and many were saved who otherwise would have died from additional traumatism and shock.

The principle of conservation of function in the treatment of fractures is well exemplified in the Willems treatment of wounds of joints. This treatment, introduced about the middle of the war by Dr. Willems, of Brussels, aims at the retention of motion of the joints by never losing it. The wounded joint is operated upon as usual, the wound "spluched," and closed entirely or partially according to whether infection is absent or present. The after-treatment, which is the essential part of the system, is chiefly carried out by the patient himself and consists in the use of the joint. He begins to move it immediately on

regaining consciousness after the anaesthetic and soon begins to use it. If a knee or ankle, he walks the day after operation. The results have astonished the surgical world. Joints that would have been doomed to ankylosis by the older methods have been perfectly preserved. Everyone who has employed the system agrees that it is marvellous. Some have complained that it lacks the miraculous power of achieving the impossible. This treatment and the discovery that synovial membranes possess great self-protection against infection, are the two great advances in the surgery of the articulations due to the war.

Of the operations devised during the war, one of the most striking is the kinematic amputation of the Italian surgeon Vanghetti. The object of this operation is to arrange the stump so that the remaining muscles may be used to direct the artificial limb or to vitalize the prosthesis. This is a distinct advance and bids fair, judging from the results obtained, to be a very successful proceedure.

The final stage in the influence of the war upon the development of medicine and surgery, lies chiefly in our own hands and depends upon the perpetuation of the cordial and fruitful relations which have existed during the war between the surgeons and physicians of the different armies. It will indeed be regrettable if the stimulus to progress engendered by the meetings of the Interallied Surgical Conference and the Research Committee of the American Red Cross should be permitted to subside. Now is the time to act when the memory of the events thru which we have passed is fresh in our minds and the friendships formed are still warm.

Military organization will have to be supplanted by some other. Shall we look to the national and international societies and congresses, or shall we turn to our great universities? The latter seems to offer the best means for fostering and perpetuating the spirit of enthusiastic co-operation brought about by the war, for they afford opportunities for continuous collaboration and interchanges of ideas. International meetings should be encouraged, not only because of their scientific value but in order to revivify the cordial personal relations which have been such a redeeming feature of the war.

In the near future it is hoped that America may have the honor and great pleasure of receiving our European brothers in order to be able to make some return for the kind hospitality, and thoughtful helpfulness and sympathetic appreciation we have always received.—*Leo. C. Donnelly, Detroit.*

A New Method of Treatment for Suppurative Arthritis of the Knee-joint. By Maj. J. Everidge, R. A. M. C. T. *The British Journal of Surgery*, Vol. VI, April, 1919, No. 24.

To sum up, the advantages to be derived from treatment by early active mobilization appear to be 5, its effects being:

1. To hasten repair by the preservation of a good blood supply to the tissues of the affected joint.
2. To aid drainage, as Willems has emphasized.
3. To prevent extreme atrophy of the muscles, so that these will be better able to resume function when the articular inflammation is at an end.
4. To establish a process of auto-vaccination.

5. To realize the possibility of a subsequently mobile joint.

On the other hand, experience has shown that the treatment is not advisable in cases with gross injury to the articular bone or essential tendons or ligaments; or where suppuration in the joint has gone on for sixteen days or more.

Bacterial invasion of synovial fluid:

1. In 70 to 80% of the cases of penetrating wounds of the knee-joint, this fluid at the original operation shows that "soiling" has occurred. In most it is not possible to see and recognize organisms in it; only on cultural examination can their presence be determined.

2. Where the "toilet operation" has been successful, these organisms disappear. Subsequent effusion, should it occur, is found to be sterile.

3. Where the "toilet operation" has failed as evidenced by the persistence or recurrence of the clinical signs of inflammation more than four days after operation, bacteriological examination reveals organisms in profusion by both direct and cultured methods.

The Cellular Elements.

1. At the original operation the identification of cells typical of inflammation is generally prevented by the presence of red and white blood-cells resulting from a hæmorrhage into the joint.

2. In the absence of such a hæmorrhage, a preponderance of leucocytes is not pathognomonic of severe septic infection of the joint.

3. A differential leucocyte count affords evidence in determination of infection. An 80% polynuclear count marks roughly the dividing line between good and bad prognosis (Lazarus Barlow).

4. The presence of extracellular organisms and of the phagocytosis, when suppuration has lasted for ten days, point to a severe infection and limitation of powers of resistance. Too much reliance, however, should not be put upon this observation.

The following changes in the nature of the fluid escaping from a joint, during the progress of suppurative arthritis, to a certain extent reflect the clinical evolution of the intra-articular inflammation. Three stages may be recognized:

A. Developing.
   1. (a) Synovial fluid discolored by altered blood; (b) Albuminous fluid like coagulating white of egg.
   2. Sero-purulent fluid.

B. Established Suppuration.
   3. Pus. (a) Thick and creamy in staphylococcal infection; (b) Thinner and less viscid in streptococcal infection.

C. Subsidence.
   4. Pus with semi-solid curds.
   5. Curds floating in a clear fluid.
   6. Synovia, clear and limpid.

The stereotyped vertical parapatellar incisions commonly used for drainage for the knee-joint have the following drawbacks:

1. Wide gaping of the skin owing to the run of the natural lines of cleavage in this situation. The result is wounds taking long to heal and ultimately leaving troublesome cicatrices.

2. Joint openings which tend to close early, since the split muscle and tendinous fibres forming the capsule fall together spontaneously.

3. Interference with the blood supply of the patella, since the main vessels, which pass transversely inward, are divided by these incisions.

4. Troublesome hæmorrhage either at the time of the operation or some hours later. The bleeding vessels shrink away into fibrous tissue when cut, and are difficult to secure.

5. Should amputation subsequently become necessary, the anterior flap is interfered with.

Owing to these drawbacks, I have for some time past been in the habit of using transverse incisions. These remain open satisfactorily and, when active mobilization is employed, appear to drain the joint just as efficiently as the vertical incisions. They are made from the outer and inner borders of the patella, commencing at the junction of the upper and middle thirds of the bone, and continuing for a distance backwards of about an inch and a half. These incisions are far removed from the lateral ligaments, which lie below and behind them. The outer incision partially divides the iliotibial band.

The apparatus for active mobilization comprises: (1) A suitable splint; (2) An overhead counterpoise system.

1. The splint: This is an elaborated back splint with foot-piece, and possesses the following features: (a) It is guttered to fit the shape of the leg (b) It is interrupted, when it lies behind the knee, to give access for inspection and dressing. (c) The metal bars bridging the interval are jointed. (d) An adjuster is fitted like that supplied with the standard McIntyre splint. This is made easily detachable; when removed, there is freedom for knee movements. (e) A foot-piece is supplied, adjustable in position according to the length of the leg. It is pivoted on the adjusting pin, and held up by two elastic slings. Thus the foot is maintained in dorsiflexion when at rest. (f) Running wheels are attached below the foot end of the splint. These prevent friction, and allow a free excursion up and down a platform on which the splint rests.

Four pulleys are attached above the leg. These transmit four cords, two of which are attached just above, and two just below, the hinges of the splint. At their other ends are fixed counterweights (sandbags, etc.) These are not quite heavy enough to suspend the leg in the air. They merely serve to overcome most of the force of gravity. With this arrangement the patient's limited energy may be economically spent on movements at the knee, and not wasted on the purposeless act of lifting the leg from the bed.

Emphasis is laid on the importance of movements of the foot. Active contractions of the muscles of the leg stimulate the flow of blood and prevent the occurrence of œdema from venous stasis. Possibly, also, contractions of the gastrocnemii help to massage up pus from the posterior compartments of the knee-joint. The physiological method, in order to be of service, must be instituted early. It is useless to commence it when all the joint structures are becoming disintegrated by septic processes, and especially when the cartilages are becoming eroded.

In the more virulent types of inflammation, and especially when it is associated with gross bone injury, movements towards the end of the third week may become restricted and painful. It is not due to a collection of pus in the

popliteal space, it is regarded as coinciding erosion of the articular cartilages, and is the signal for the application of a rigid Thomas splint with extension, hope of a mobile knee being no longer entertained.

Such an occurrence is not to be regarded as complete failure, for experience shows that the measures adopted early have served the following purposes: (1) Prevention of tracklings; (2) Hastening of resolution of the septic processes within the joint by stimulation of the synovial circulation; (3) Limitation of the intensity of the inflammation and of toxic absorption.

Not the least striking feature when this treatment is carried out is the satisfactory general condition these patients preserve. Their appetites remain good; they sleep well; take interest in their surroundings; and, in fact, present an entirely different picture from that which we were accustomed to see when treatment by immobilization was carried out.

Anatomical Methods of Approach in Operations on the Long Bones of the Extremities. J. E. Thompson. *Ann. Surg., Phila.*, 1918, lxviii, 309. Vol. XXIX, July, 1919, No. 1. *Surg. Gyn. and Obst.*

The author has made an extensive study of the long bones and the best routes by which they can be reached, summing up the results of this study as follows:

The best routes to expose the tibia are:

1. Along the line of its subcutaneous surface from the medial tuberosity proximally to the tip of the medial malleolus distally. This is the route of choice.

2. Along the line of the medial border of the tendo achillis and the flexor pollicis longus to expose the posterior surface of the distal end of the shaft for tendon implantation and fixation.

3. Along the line of the lateral border of the tibialis anterior to expose the anterior surface of the distal end of the shaft for tendon implantation and fixation.

To expose the fibula the best routes are:

1. Along the line of the subcutaneous surface of the lower fourth of the shaft and the lateral malleolus.

2. Along the posterior peroneal septum for the upper three-quarters of the shaft.

For the exposure of the femur, the author recommends the following routes:

1. Vertically upward from either lateral or medial epicondyle for the lower epiphysis and the lower quarter of the shaft.

2. An anterolateral incision lateral to the rectus femoris for a small area at the juncture of the middle and lower thirds of the shaft.

3. An external incision for the upper three-quarters of a shaft along a line drawn from the tip of the trochanter major to the outer border of the patella.

4. Between the vastus lateralis in front and the short head of the biceps cruris and the insertion of the glutaeus maximus behind, along a line extending from the posterior border of the great trochanter proximally to the posterior border of the lateral condyle distally.

5. Along the line of a medial incision extending vertically upward from the abductor tubercle, to expose the posterior surface of the lower fourth of the shaft (popliteal surface).

6. The anterior oblique incision lateral to the line of the upper end of the sartorius muscle for the exposure of the hip joint, the neck of the femur and the upper part of the shaft.—*Leo. C. Donnelly, Detroit.*

Curvatures of the Spine in Growing Children. By E. H. Bradford, M. D., Boston, Professor of Orthopædic Surgery, Harvard University Medical School. Vol. CX, No. 1, July 5, 1919, Whole No. 2118. *New York Medical Journal.*

In eight concise pages, Dr. Bradford summarizes practically all that is good concerning curvatures of the spine in growing children. The article is so concise that it does not easily permit abstracting.

The conclusions reached in many years of observation of this class of deformities may be summarized as follows:

When treatment is needed, early treatment is important.

The amount of abnormal spinal rigidity as well as the degrees of the curvatures or twists are important factors to be considered.

The method of treatment employed, whether gymnastic, corrective, or mechanical, should be used with a precise purpose and with a definite knowledge of the results obtained.

The comfort and contented coöperation of the patient is an important factor in securing the best results and, next to hygenic measures, one of the most important adjuvants in treatment.

Children with curved spines may be classed: (1) Those sitting or standing in faulty attitudes from indolence, weakness, careless habits or faulty clothing. (2) Those with changed structure in the spinal column or where such change is threatened.

The first class is helped with little difficulty or grows naturally to a normal type if in healthy surroundings. The second class needs careful examination and special treatment. In some cases an adaptation of school study period is necessary.

It is, as a rule, undesirable that the attention of young girls should be called to any peculiarities in their figure.

To determine any changes in structure of the spine, back view contour tracings alone are not sufficiently reliable. For accuracy, side view tracings should also be taken, freed from the misleading position of the movable shoulder blades.

It is always necessary to examine the movement and change in stiffness of the spinal column itself and the degree of twist if any is present.

Children do not grow evenly and they normally pass thru different stages of attitudinal habits. They tend to grow true to normal type, unless this is interfered with by ill health or unfavorable conditions.

As the variations of attitude are many the shapes of the back are correspondingly varied, but these normal varieties may be grouped as flat backs, round

backs, hollow backs, flexed backs and curved backs. These attitudinal flexible curves are so common that they cannot always be justly called pathological, as the majority correct themselves. The abnormally stiff curved backs and twisted backs are to be regarded as pathological.

To what extent the variations of the attitudinal curves are in danger of becoming pathological, i. e., exceeding the limit of normal health, is a question of opinion. This opinion should be based upon as accurate observance as possible on the probable existance of any structural change in the spinal column, indicated by abnormal stiffness as well as faulty curves and assymetrical contours.

The chief obstacles to the growth of a child of normal type without the development of structural changes are: Poor health, poor environment, rapid growth, faulty clothing and deforming occupations and habits, including an excess of seated and inactive hours.

Growing girls in good health with only slight attitudinal curves need only occasional, if any, observation.

Girls with increasing attitudinal curves and marked and increasing structional change need vigorous, thorough treatment especially if not strong.

In growing boys with flexible spinal curves, the need of treatment is dependent upon the outdoor play, activity, vigor, rate of growth and the health of the boy.

Desultory and unsystematic treatment is of little use in the correction of curves. If treatment is undertaken it should be vigorous, systematic and regular.

Growing girls should not be made unduly conscious of physical defects in shape, as there is a danger of exaggeration.

As early treatment is of great importance, mothers should periodically examine the backs of these children and be cognizant of the plain facts in regard to spinal curves. The school nurse should be well informed in the subject. The general physician can easily familiarize himself with a working knowledge which would enable him to guide the management of these cases in their growing years.

The schools can be of help. An observant teacher who watches her class should be able to classify them in A, B, C, and D groups, according to general condition, evidences of vigor, and flatchested, roundshouldered, crooked sitting and standing attitudes commonly assumed. The C classes will need careful observation and the D class thorough examination by some one well informed in the matter.

With a widely diffused knowledge of the subject and a general appreciation of the facts of the case, curvatures of the spine should disappear in our community. The school children and women would present better and stronger figures and the rank and file of our men be more upstanding.

The statistics furnished by the draft boards show that our population is physically below what it should be in our land of abundance. The soldiers returned from the training camps have taught what can be done with the average slouching street boy, farm hand and college student. Prevention is more important than cure. Curvatures of the spine are notably preventable.—*Leo C. Donnelly, Detroit.*

GUNSHOT FRACTURE OF THE FEMUR. By J. R. Buchbinder, M. D., Chicago. Vol. XXIX, July, 1919, No. 1. *Surg. Gyn. and Obst.*

We must systematically begin the treatment of such fractures with several very definite objects in view, namely: Immediate reduction and fixation; the earliest possible control of wound infection; ease of access to the thigh at all times for inspection and palpation; repeated X-ray control until bony union has occurred; a means of easily moving the patient without disturbing the fracture; and early and constant mobilization of the knee joint. It should be a cardinal rule that every fracture, regardless of its type or location, be reduced as quickly as possible, and permanent fixation applied. Mal-position of the fragments of a fracture traumatizes the soft tissues.

There are two methods of immobilizing the fragments of any fracture. The first is traction; the second, some type of fixation splint or open operation. Over-riding is an almost constant accompaniment of these fractures; neither plaster nor splints will correct this. Primary use of the Lane plate would certainly invite infection in the majority of cases. Buck's extension, its principle embodying the use of adhesive strips upon the skin upon which traction is made by means of weights and pulleys, is the method most commonly used. It is easily applied, is relatively comfortable, and in many cases it reduces the overriding, particularly in simple fractures. It is not an infrequent occurrence to discover that no amount of pull that can be safely exerted upon a Buck's apparatus, will be sufficient to correct the overriding.

The Steinman pin or so-called nail extension offers an almost ideal means comfortably and safely of maintaining accurate apposition. The original method consists of driving a nail, one-eighth of an inch thick and some inches long, thru the condyles of the femur, and making traction from the projecting ends. A more satisfactory modification consists of the "ice tongs" or "caliper," in which the nail on each side is driven merely thru the compact bone of the condyles.

When it is not necessary to do other operative work upon the thigh requiring a general anaesthesia, the caliper may be attached under local anaesthesia. The site chosen is the most superficial point of the condyle on each side. A knife puncture down to the periosteum is made, the points of the capiler inserted and then hammered into the bone about one-fourth of an inch.

Traction upon the distal fragment is absolutely certain regardless of its length. Reduction is maintained with considerably less weight than is possible with adhesive. The entire leg and thigh are free from any other incumbrances necessary for traction. The thigh is readily held clear of the bed so as freely to expose the entire posterior surface without a supporting splint or counter traction. The patient is entirely free from any discomfort due either to traction or to the wounds made by the nail punctures. These wounds, when made thru a clean area, do not become infected.

The use of the nail extension leaves the knee comfortably mobile from the moment of its application. It has been our custom to apply to the foot of the injured side a plaster shoe extending just above the ankle. A rope imbedded in the dorsum of the shoe leads upwards over a pulley and then down to within easy reach of the patient's hand. The shoe prevents foot drop; by means of the

rope he is able easily and frequently to flex and extend the knee. A most surprising feature of this procedure is its absolute painlessness; and it assures a joint with a full range of motion when bony union has occurred.

Fractured femurs are suspended on gas pipe Bradford frames with Balkan frame attachment in such a manner that the nursing care of the patient does not disturb the fracture.

Treatment of sepsis of compound fractures is sanely discussed.—*Leo. C. Donnelly, Detroit.*

Treatment of Slightly Infected Gun-Shot Wounds of the Joint. Paul Mollenhauer and Leo Mayer. *Orthopadische Chirurgie.* Vol. 38, No. 3 and 4.

The gun-shot wounds of the joint are divided in two groups

1. Those with extensive destruction of the joint and severe infection, making extensive interferences necessary. The outcome is always loss of function of the joint.

2. Gun-shot wounds of the joint with slight, usually limited, inflammation, and even an afrebile course.

It is in the latter group of cases where the question arises whether or not an operative interference is necessary at all.

The removal of the bullet is indicated in the following instances:

1. Continued increasing pain.
2. Limitation of joint motion.
3. Tedious sinus formation without tendency to healing.
4. Formation of pus and danger of joint infection.

Several cases are reported illustrating each of the points mentioned. In each case the operative technic is carefully given.

The technic of the removal of the projectile presupposes accurate localization of the foreign body. This may be carried out easily in the presence of sinuses but in other cases direct localization will meet with difficulties. During the operation it is necessary to avoid traumatizing the joint or other important anatomical structures. Regarding the approach, the trap door incision over the malleolus as approach to the talo-tibial joint has proven very satisfactory and likewise the approach thru the Tendo-Achilles to the sub-astragaloid joint.—*Arthur Steindler, Iowa City, Ia.*

Contribution to the Treatment of Infected Gun-Shot Wounds of the Hip. Leo. Mayer. *Orthopadische Chirurgie.* Vol. 38, No. 3 and 4.

The author furnishes most interesting illustrations showing very remarkable results after severe gun-shot wounds of the hip. All cases were treated by resection of the hip, in some instances a considerable portion of the bone being removed. The author thinks that as soon as the diagnosis of superative arthritis of the hip following gun-shot wounds is made, the operation should be performed. Only in the case of other severe wounds should the exarticulation of the hip be considered.

Where the hip alone is involved there are only two alternatives:

1. Simple drainage.

2. Excision of the head and neck of the femur and of the infected part of the shaft.

In regard to the technic, in two cases a vertical incision was made behind tensor fasciae. In two other cases it was necessary to apply a curved incision. In the fifth case a long straight incision, three inches long, at the anterior bor der of the tensor fasciae sufficed.

After removal of bone the wound should be packed with gauze. A plaster paris bandage is not to be advised since traction in 20 degrees abduction with ten pound weight is sufficient. There is no need of any special apparatus.

Considering the grave prognosis of supperative hip joint contracture the results obtained by the author are really remarkable. All of the five cases reported recovered. All patients were able to walk. Four cases healed with moveable joints, some of them show a most remarkable range of motion. In only one case did the joint become ankylosed.—*Arthur Steindler, M. D., Iowa City, Iowa.*

THE SURGERY OF TENDON TRANSMISSION WITH SPECIAL REFERENCE TO THE IMPORTANCE OF THE TENDON SHEATH. By A. M. Bernstein, M. D., Vol. XXIX, July, 1919, No. 1. *Surg., Gyn. and Obst.*

The author first discusses methods of tendon transposition brought out by the earlier writers.

The general criticism of these methods is (a) that in all of them, the healthy tendon (whether anastomosed to the diseased tendon or directly implanted in its new insertion) is first isolated from its normal anatomic surroundings; and (b) that the tendon with its surrounding structures is subjected to a greater or less amount of operative traumatism; (c) that but little thought is given to the importance of a tendon being reconstituted normally as regards its working surroundings or to the pathological conditions that could and do arise as a result of the operative trauma and which interfere with the subsequent action of a transposed tendon or with its nutrition.

He next discusses the anatomy of tendons and peritendinous tissue especially discussing the work of Lovell, Tanner and Mayer. The reasons advanced by various authors for the failure of tendon transposition are discussed.

The conclusion that is fairly deducible from a study of the clinical results, appears to be that there is a general concensus of opinion that tendon transposition is a practical and valuable surgical procedure, but that none of the existing methods of performing it is entirely satisfactory as regards the functional end-results. It is also clearly seen that the occurrence of dense adhesions about the transferred tendon is one of the chief factors resulting from the operation which tends to make it a functional failure.

Consideration of these experimental findings makes it quite clear that the function of a surgically transposed tendon separated from its normal surrounding structures is interfered with (1) by disturbances of its nutrition; (2) by mechanical obstructions to its motions, i. e., adhesions; (3) by a change in the nature of its regenerated tissue. As a corollary, it would seem that the

true physiological method of transferring the function of a tendon to a new insertion is to transpose it with its necessary peritendinous structure and with the minimum amount of surgical traumatism.

In his own method of transposing the tendon with the sheath and the peritendinous tissues, a special technique is adopted. After incision of the skin and superficial fascia, the skin is retracted and the tendon in its sheath exposed to view. The tendon sheath is not opened. Where two tendons occupy the same sheath as much of the sheath is carried over with the transposed tendon as is necessary to repair the defect. Special fixation sutures are introduced at the point where the tendon is to be cut. After inserting the fixation sutures, an incision is carried laterally on both sides of the tendon for about one-fourth inch and the tendon severed. The tendon, still in its sheath, is carefully raised by means of the fixation sutures, the special object being to avoid all possible trauma by handling, etc., and a scissors cut thru the peritendinous tissue only on each side of the tendon. The isolation of the tendon is carried to the lower muscle fibers. A probe is now introduced along the paralyzed muscle, taking into account the special anatomical relation of the septum which separates the adjacent muscles, viz., the fascial planes; the probe is then carried under the ligamentary structures, as for instance, the annular ligament, and brought out at the new implantation site. The fixation suture is now attached to the eye probe and carried down thru the new canal. The transposed tendon is fixed in its new implantation. Thruout this entire operation the tendon is protected by its own normal coverings. The period of immobilization varied from 8 to 21 days after operation.

The central fact is the absence of all inflammatory processes between the tendon and the sheath, and further there is no opportunity for the occurrence of adhesions. The epitenon and endotenon remain unimpaired. Such reaction as is observed has very little effect on the functional action of the transposed tendon.

The description of the author's operation is so well illustrated that studying the illustrations renders reading the text unnecessary. — *Leo. C. Donnelly, Detroit.*

Treatment of Flail Joints Following Resections. (Traitment de laxités articulaires consécutives aux résections.) Tavernier, L., and Jalifer. *Lyon chirug.*, 1918, xv, 399.

The authors report their experience in the surgical treatment of flail-joints occurring after defective resection or resection with too free an excision of bone.

In the case of the knee, complete and solid ankylosis is absolutely necessary for the functional use of the limb; and articular laxity demands a secondary operation.

Although the authors have only operated in cases of actual flail-joint, their results have been so satisfactory that they think that every case of exaggerated laxity should be treated by metallic sutures.

Vol. I, No. 10 OCTOBER, 1919 Old Series: Vol. vxii, No.10.

The Journal of Orthopædic Surgery

THE DIAGNOSIS AND PRE-OPERATIVE TREATMENT OF NERVE INJURIES.

BY MURRAY S. DANFORTH, MAJOR, M. C., U. S. A., PROVIDENCE, R. I.

This paper is based on a study of the patients suffering from nerve injuries who were treated in the Service of Colonel Sir Harold Stiles at the Edinburgh War Hospital, and it is due to his kindness that I am permitted to make this report.

Originality for methods is not claimed though many were developed independently. My object is to describe such features as were found valuable and necessary in the routine care of this class of injury. *The paper is divided into a section on Diagnosis*, which *includes the history taking and examination*, and a section on *Pre-operative treatment.*

The History.

The usual medical history is taken and the following points especially noted:

1. *The date of the wound.*
2. *The character of the wound*, particularly how much suppuration occurred.
3. *The date of the healing*, showing the period of suppuration and how long the wound has been healed.
4. *Did the paralysis occur at the time, or did it come on subsequently*, as might be the case if the lesion were due to compression from scar or by the formation of callus.
5. *Whether the patient has observed if the paralysis is increasing or diminishing.*
6. *Whether the areas of anaesthesia are increasing or diminishing.*

The Examination.

1. *A routine physical examination is made.*
2. *Examination of the special condition. This may be subdivided as follows:*

(a) *The location of the wounds or scars*, indicating whether by their position nerves might be involved by the scar or whether the missile in its course might have involved a nerve or nerves. This is helpful in distinguishing so-called functional paralysis from paralysis due to actual injury of the nerve.

(b) *The character of the scar:*

1st: Is it soft and non-adherent, or soft and adherent.

2nd: Is it indurated.

3rd: Does it suggest the probability of latent infection.

(c) *The condition of the joints in the affected extremity:* It is of much importance to describe briefly, but very accurately, the range of voluntary and passive movements in all the joints of the extremity, both proximal and distal to the site of the supposed nerve injury. Only in this way can a definite determination of subsequent progress be made.

(d) *The examination of the muscles* in the affected part: This is done *first by testing their voluntary power, and secondly, by testing their electrical responses.*

1st: The voluntary power:

For determining the presence or absence of voluntary power in muscles, a very considerable amount of experience is necessary, as much or more than for determining the electrical responses, but the information gained is of equal or greater value. The necessity of treatment, operative or otherwise, is chiefly dependent upon the function of the extremity, that is the voluntary control of the muscles. For the testing, the examiner must have an accurate knowledge of the location and relation of the muscles to be tested, of their actions and of the positions of the parts and of the movements by which contractions of the given muscles can be produced.

In making the test, the extremity is placed in such a position as to partly relax the muscle to be examined and

is supported, or forcibly held in that position by one hand of the examiner. The patient is then asked to try to make the movement that is known to cause contraction of the given muscle. So far as possible it is desired to get a movement that causes contraction only of that muscle. *The examiner watches for contraction in the muscle or tightening of its tendon, and also, of course, for motion imparted, but absence of the last is of no importance if there is definite contraction of the muscle, even though too weak to cause motion. In many instances, the determination depends upon palpation for contraction in the muscles and for tightening of the tendon. Contraction in the muscle means voluntary power. Tightening of the tendon means voluntary power unless it is due to change in the position of the joint from contraction of the opposing muscles.* (For example: Frequently in complete paralysis of the muscles supplied by the external popliteal nerve, the patient in attempting to dorsiflex the foot and toes will actually plantar-flex the foot and toes, and in so doing will tighten the tibial anticus and the long extensors of the toes. This source of error is eliminated by forcibly holding the foot and toes immovable and then tightening of the tendon of the tibialis anticus or the tendons of the long extensors of the toes can come only from shortening due to contraction of the muscle in question.) Sometimes, many attempts are necessary to determine the presence or absence of voluntary power. In case no contraction is seen or felt, the same test should be tried on the opposite extremity, so that the patient may understand exactly what is desired. If this does not result in demonstrating voluntary power on the affected side, the patient should be required to try to make simultaneously the same movement with both extremities. Sometimes this results in contraction of the supposedly paralyzed muscle. If it does not, the patient is required to make the movements simultaneously on the two sides, but against strong resistance on the normal side. In so-called functional cases, this will frequently result in contraction of the affected muscles. Another method is to ask the patient to make the desired

movement and then the examiner carries the joint through the movement. This is done several times, then the examiner at one stage in the motion quickly makes the opposite motion. In functional cases, the stimulus of this sudden stretching usually will cause the muscle to contract.

2nd: The testing of the response of the muscles to electrical stimulation:

For this purpose, an ordinary combined battery was used,—the limit of the galvanic current being what could be obtained from forty dry cells. By appropriate switches, the current could be changed from faradic to galvanic, and from galvanic to faradic as desired and without moving the electrodes. *The response to faradism is tested first.* The large (indifferent) electrode is placed on the back over the sacrum or between the shoulders. The motor point of the muscle is sought with the small electrode. The response, or lack, is noted and comparison is made by testing the same muscle of the opposite extremity. The amount of current is increased gradually to the limit of tolerance, unless response is obtained earlier. *If no response, the current is changed to galvanism. With galvanism, the character of the contraction is the important feature. It may vary all the way from the quickly appearing sharp contraction of a normal muscle to the slowly appearing slow contraction and slow relaxation of the muscle whose nerve supply is cut off. This delayed appearance of the contraction and slow contraction and slow relaxation are the points to be noted. Polar changes were, so far as we could determine, of no value in determining the extent of the nerve lesion.*

For the recording of the voluntary power in muscles and the electrical responses, and for help in ascertaining the extent of the nerve lesion, special so-called muscle charts were devised, giving for the upper extremity, the muscles supplied by the musculo-cutaneous, the musculospiral, the median and the ulnar nerves in the order in which their branches are given off from the parent nerve, and for the lower extremity, a chart was made of the muscles supplied by the sciatic and internal and external

popliteal nerves. Following the muscle column were columns for recording the voluntary power, the response to Faradic stimulation and to Galvanic stimulation, and a column for remarks. Thus

For the upper extremity:

		Vol. Power	Far.	Gal.	Remarks
Musculo-cutaneous	Biceps				
	Brachialis				
Musculo-spiral	Triceps: Outer head				
	Triceps: Long head				
	Triceps: Inner head				
	Brachio-radialis				
	Ext. Carp. Rad. Long				
	Ext. Carp. Rad. Brev.				
	Ext. Comm. Dig.				
	Ext. Min. Dig.				
	Ext. Carp. Ulnar				
	Ext. Os. Meta. Poll.				
	Ext. Poll. Long.				
	Ext. Poll. Brev.				
	Ext. Indicis				
Median	Pron. Rad. Teres				
	Flex. Carp. Rad.				
	Palmaris Long				
	Flex. Dig. Sub.				
	Flex. Dig. Prof. (1				
	(2				
	Flex. Poll. Long.				
	Abduct. Poll. Brev.				
	Opponens Poll.				
	Flexor Poll. Brev.				
	Lumbricales (1				
	(2				
Ulnar	Flex. Carp. Ulnar				
	Flex. Dig. Prof. (3				
	(4				
	Abduct. Min. Dig.				
	Interossei				
	Lumbricales (3				
	(4				
	Adduct. Poll.				
	Flex. Poll. Brevis				

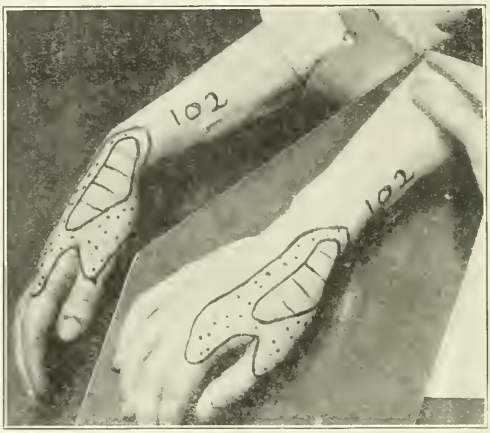


FIG. 1.

FIG. 2.

No. 407110, Sgt. Levy; admitted July 29, 1918; complete musculo-spiral paralysis.

Fig. 1 shows extent of drop wrist and areas of anaesthesia, Aug. 15, 1918.

Fig. 2 February 14, 1919, three months after operation, showing improvement and ability to extend the hand on the wrist.

For the lower extremity:

		Vol. Power	Far.	Gal.	Remarks
Sciatic	Biceps				
	Semi-membranosus				
	Semi-tendinosus				
External Popliteal	Peroneus Longus				
	Peroneus Brevis				
	Ext. Com. Digitorum				
	Tibialis Anticus				
	Ext. Prop. Hallucis				
	Peroneus Tertius				
	Ext. Brevis Digitorum				
Internal Popliteal	Gastroenemius				
	Soleus				
	Tibialis Posticus				
	Flexor Long. Digitorum				
	Flexor Prop. Hallucis				
	Abductor Hallucis				
	Flexor Brevis Digitorum				

Symbols were used to denote weak power, fair power, normal power, no power, and for the electrical testing, weak response, fair response, good response, and no response. In this way a complete examination of the muscles could be made and rapidly recorded, and there was no possibility of muscles being overlooked.

(e) *The examination of the Cutaneous Sensibility:*

Two tests were used, sensibility to cotton and to pin prick. It is essential that the patient not be allowed to look at the part being tested. The area is shaved if needed. The testing is done by going from the anaesthetic or hypo-aesthetic area to the normal area. Cotton is first used and the area of anaesthesia marked out with a black wax pencil. Then the area of analgesia is marked out with a red or other colored pencil. *For recording the changes in sensibility, the charts prepared by Col. A. M. Patterson of the Imperial Medical Service and Professor of Anatomy at the University of Liverpool, were used.* These were helpful in that not only they showed the area supplied by the nerves but showed the root distribution of the nerves.

FIG. 3.

FIG. 4.

No. 709871, Pvt. Gayton; wounded Feb. 22, 1917; exploration musculo-spiral July, 1918; ends could not be approximated.

Fig 3, November 10, 1918, before operation; note drop wrist in left hand and inability to abduct thumb as compared with the right hand above.

Fig.4, April 9th, following, shows improvement in wrist, fingers and thumb.

(f) *Description of the Trophic Disturbances:*

The points noted were the changes in the color and other appearances of the skin, as scaliness, sweating, dryness, the changes in the nails, and the nutrition of the muscles. Frequently an ulnar or a median lesion could almost be diagnosed from inspection of the part alone.

(g) *Distal tingling:*

There has been doubt about the value of this sign but in certain instances in which there was no other evidence of physiological continuity of the nerve a reasonable assurance of its physiological continuity was found in this sign. Caution must be used in the testing, however. We found it essential to begin far distal to the site of the injury of the nerve and approach the site slowly along the course of the nerve. To avoid the danger of the patient's imagining that he felt tingling we only accepted it as positive evidence in cases where the area localized by the patient as the place of tingling was included very definitely in the area normally supplied by the nerve. Gradual extension distally of this phenomenon was an added help.

The Diagnosis.

The examination outlined above furnished the basis for the diagnosis and determined the treatment. Single examinations were never accepted as sufficient to indicate operative measures, except possibly the correction of deformities. As a rule, one examiner made all the tests. In this way it was possible for him to note at once any apparent discrepancies between the results of the voluntary power tests and the electrical responses, or between changes in muscle power and changes in cutaneous sensibility. In case of apparent discrepancy, the tests were gone over until the discrepancy was removed, or the reason for it ascertained, if possible.

Complete loss of voluntary power with loss of faradic excitability and with slow galvanic response, associated with anaesthesia and analgesia, over the area supplied by the nerve and absence of distal tingling distal to the site of injury, means physiological loss of continuity in the nerve trunk. Only repeated

FIG. 5.

FIG. 6.

No. 10916, Pvt. Hearle; wounded April 23, 1915; July, 1915, operation musculospiral not united. Tendon operation August, 1918.

Figs. 5 and 6 show improvement in the degree of flexion-extension of the wrist and abduction of the thumb, before and after operation.

examinations can indicate the probability of anatomical loss of continuity, or that recovery will not take place.

Voluntary power was frequently found to be present in muscles showing no Faradic response with one electrode only applied to the muscle. Probably with a very strong current and both electrodes on the muscle, contraction could have been produced, but certainly not the normal response.

In certain cases no voluntary power would be found in muscles showing good faradic response, but almost invariably at a subsequent examination, power would be shown. This condition occurred in the so-called functional paralysis,—a condition which was usually found to yield quite promptly to appropriate treatment.

The general working rule was to wait six weeks to two months after complete wound healing before operating, and during that time the patient had two and usually three complete examinations. In addition, a voluntary power examination was made each week. If at the end of six weeks or two months, it was found there was no change in the condition and that the examination showed a complete loss of physiological continuity, or incomplete but unchanged loss, operation was done, if the amount of disability warranted it. In a few instances in which the patient had been under observation previous to the wound healing and sufficient evidence was at hand to justify diagnosis of complete division, the operation was done less than six weeks after the wound healing. This was, however, only in exceptional circumstances. In our work the condition at operation was almost invariably found to be more extensive than the clinical examination would indicate.

The Pre-operative Treatment

The interval of six weeks or two months between the time of wound healing and the possible operative treatment was employed in improving the nutrition of the muscles, correcting any deformities and restoring flexibility of the joints in the affected extremity. The necessity of this preliminary treatment of correcting deformities and restoring movement in joints when possible was shown by a study of some of the earlier cases which were operated upon without any previous preparatory treatment.

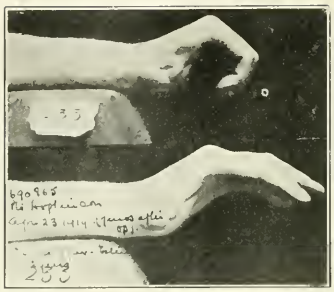


FIG. 7.

FIG. 8.

No. 201383, Pvt. Tucker; wounded October, 1917; nerve operation March, 1918; tendon transference December 9, 1918.

Fig. 7 shows function four months after operation.

No. 690865, Pvt. Hopkinson; wounded October, 1917; tendon operation September, 1918. Extensor ossis metacarpi pollicis to the flexor digitorium sublimis flexor carpi ulnaris to the flexor digitorium profundi.

Fig. 8 shows possible function seven months after operation.

If no deformities were present, the muscles were protected from stretching by appropriate splinting. This was found to be a very important feature and its lack was often sufficient to retard or prevent restoration of power in the muscles, and further, it was found necessary to maintain this relaxation constantly. This was perhaps especially so in circumflex, musculospiral and external popliteal paralysis, but undoubtedly is nearly as necessary in all nerve injuries.

In addition to the protection given by splinting, the muscles were treated by hot soaks, or whirlpool baths, followed by massage and either active or passive motions, and electrical stimulation.

In cases in which deformity was present, the *deformity* was corrected. *The most common deformities found* were adducted shoulders, palmar-flexed wrists and plantar-flexed feet. The shoulders were usually corrected by manipulation under an anaesthetic and application of a plaster of Paris jacket with an arm piece holding the arm in 90° of abduction and slight external rotation. The top of the arm part was removed to allow of treatment. The palmar-flexed wrists were corrected by manipulation under an anaesthetic and application of a plaster of Paris cast maintaining the dorsi-flexion. After ten days to two weeks the cast was removed and active stimulative treatment begun. The plantar-flexed feet were corrected by manipulation under an anaesthetic with or without lengthening of the tendo Achillis as the condition required.

The restoration of flexibility of joints was perhaps the most difficult part of pre-operative treatment and the finger joints the most difficult of all joints. For these small joints various methods were tried. Massage and hydrotherapy were found successful in a few instances. Forcible manipulations with or without anaesthetic were found helpful in only a very few instances, and much more often rendered the joints stiffer. Finally elastic traction was tried; at first pulling in direct flexion if it were that the fingers were fixed in extension. This was helpful in a certain number of cases, and never made the condition worse. Then elastic traction in the direction to first stretch the joint capsules was tried. This was found a great advance. One of my colleagues, Lieutenant-Colonel Baldwin, devised a very successful splint to apply this traction, and also splints were made from plaster of

FIG. 9.

FIG. 10.

FIG. 11.

No. 454818, Pvt. Cousineau; wounded March, 1917; tendon operation November, 1918; transference of flexor carpi radialis to the extensor digitorium communis and extensor secundum internodii. Also the palmaris longus to the extensor primas internodii pollicis and to the extensor ossis metacarpi pollicis.

Figs. 9 and 10 show condition November 6, 1918, with drop fingers and wrist and adducted thumb.

Fig. 11 shows condition on March 5, 1919, three and one-half months after operation. This patient always had voluntary dorsiflexion of hand. Tendon transference was to fingers and thumb. Improvement in extension is shown by lower figure.

Paris with a racquet shaped wire attached. *The traction was applied by strips of adhesive on the sides of the fingers to which elastic bands were attached, and these in turn attached to the splint. The pull was at first always in the line of the deformity and then gradually changed as the motion in the joints permitted. Sometimes metacarpo-phalangeal joints which had been fixed in hyperextension for months would be completely flexed in two or three weeks, but usually several months were required.* It was found essential to have massage and passive motion used daily in association with the treatment. Active movements were always used if there were any power in the muscles controlling the joints. After the metacarpo-phalangeal joints had become flexible, the adhesive strips were applied only over the two distal phalanges and work begun on the proximal interphalangeal joints. These joints usually gave much less trouble.

In a few instances, similar traction splints have been used for deformities and stiffness of toes, and in the few instances tried have been successful. In other joints restoration of motion was less essential to successful nerve work perhaps, but every attempt was made to gain flexibility.

Resume.

The diagnosis depends upon careful history taking and careful examinations made at frequent intervals and so accurately recorded that any change would be shown at once by a comparison of the different sets of records. The question of operation was decided by a study of these records. Absence of improvement during a period of two months following complete wound healing was held to be an indication for exploratory operation if the motor loss, cutaneous sensibility loss, trophic disturbance, or presence of pain constituted an actual disability.

The special points about pre-operative treatment learned in our study were the necessity of protective splinting, correction of deformities, and restoration of flexibility of joints, especially the smaller joints of the hand.

OPERATIVE TREATMENT OF PARALYTIC CONDITIONS OF THE UPPER EXTREMITY.

ARTHUR STEINDLER, M. D., F. A. C. S., IOWA CITY, IOWA

From the viewpoint of functional grouping of affected muscles three types may be distinguished in spinal paralysis of the upper extremity.

1. The shoulder type, involving deltoid, supra and infraspinatus muscles; inability of elevation and outward rotation of the shoulder.

2. The shoulder and elbow type involving also the coracobrachialis, brachialis anticus muscles, triceps, the supinators and often also the extensor muscles of the forearm; loss of shoulder action and of flexion in the elbow; pronation contractures.

3. The general type, involving additionally the muscles of the forearm and wrist more often and more completely the extensor groups, and very frequently the intrinsic muscles of the hand.

In general, fingers and wrist much more frequently escape paralysis than shoulder and elbow.

From the viewpoint of radicular distribution, group 1 represents 5th and 6th cervical root, group 2 the 5th, 6th and 7th cervical root, group 3 the 5th cervical to the 1st dorsal root.

But inasmuch as the spinal motor roots are not representative of the grouping of the motor nuclei in the anterior horn one must look to the topography of the motor cell groups for an answer to the question regarding the functional relationship of paralyzed muscle groups. Some knowledge of individual motor nuclei in the anterior horn has been gained by the studies of Sano, von Gehuchten, A. Bruce and others. We know that the cell columns appear on cross sections in typical clusters, a antero-median portion representing the dorsal and thoracic muscle groups, while the columns for shoulder, elbow and hand appear successively in columns occupying the antero-lateral, lateral, postero-lateral and central fields of the anterior horn. That these topographical arrangements are really based upon functional relationship of neighboring motor columns and that they, therefore, represent motor centers of the lower order, we have reason to believe not only from study of the cervical, but also

of the better known lumbo-dorsal intumescence of the spinal chord.

Such pathological changes, therefore, may result in clinical paralysis of coordinated muscle groups, not conforming to either peripheral or radicular distribution. Consequently in attempting to reconstruct the function surgically or otherwise one is often confronted by a multiplicity of deficiencies which, though co-ordinate among each other, call for a number of distinct operative interferences.

The essential requirements of function of the upper extremity are:

Active abduction, or a position of abduction of the shoulder, the ability of flexion in the elbow, the ability of pronating the forearm, of hyperextension, either active or passive, of the wrist and active flexion of the metacarpo-phalangeal joints, free play of the fingers and the power of opposing the thumb to the fingers.

The problems considered are:

1. To procure abduction of the shoulder.

2. To procure position of flexion in flail elbow.

3. To overcome flexion contraction in the wrist and substitute for it stable hyperextension.

4. To overcome the claw hand deformity, and secure flexion motion of the metacarpo phalangeal joint.

5. To procure for the thumb power of opposition and active extension.

I. Flail Shoulder.

Neither the study of the literature, nor any of his own attempts have been able to convince the writer that there exists a reliable and practical method of tendon transplantation in cases of flail shoulder. Here the loss of the deltoid, supra and infraspinatus is often accompanied by subluxation of the humerus. If the triceps muscle is intact, stabilization of the head of the humerus in the socket can be accomplished and some patients are able to effect some abduction of the shoulder by contraction of this muscle, which presses the head against the glenoid cavity. Others are able to do so by sharply flexing the elbow, and in this way bringing about tension of the triceps muscle. The shoulder movements may then be governed by the

trapezius muscle. The indication in cases of flail shoulder is arthrodesis. We have not found it necessary that it be a complete arthrodesis, however.

Pre-operatively muscle development of the shoulder muscles is obtained by gymnastic.

Operative technic: Horseshoe incision circling the acromion, the outer end of the incision being extended over the spine of the scapula. The deltoid muscle is isolated. The acromion is cut

FIG. 1
Case M. C. Arthrodesis of Shoulder

FIG. 3
Case J. T.—Elbow Plasty

FIG. 2
Case M. C.—Observation 9 Months

FIG. 4
Case J. T.—Observation 15 Months

through ½ inch from its edge and the deltoid with the acromial insertion is turned downward. This approach gives good access to the shoulder joint. Part of the head is resected and the glenoid fossa is reamed out. The raw bone surfaces are united with wire or strong cat-gut sutures. The capsule is reefed and closed.

I found it practical to transfer the deltoid flap backward toward spine of the scapula, forcing the head of the humerus forward. This seems to give the trapezius a better control of the shoulder movement.

The shoulder is held in platform splint at right angle for 4 months.

Number of cases operated 4.

Average age of patients 15 years.

Average duration 6 years.

Average time of observation after operation 8½ months.

Result: Good (active elevation from 75 to 90 degrees) 3 cases. Fair: (active elevation 45 degrees) 1 case.

II. Flail Elbow

The problem of flail elbow causes considerable difficulty as the arthrodesis cannot be undertaken in children under 14 or 15 years of age and is even then doubtful. In regard to silk ligament fixation of the elbow, the author has had no experience and cannot judge the applicability of this method. In a number of cases of flail elbow I have been able to apply the following operative method:

1. Incision is made on the inner side of humerus around the internal condyle. The ulnar nerve is exposed and drawn backward. From the muscles arising from the inner condyle, a flap is very carefully dissected off subperiosteally to the length of 1½ inch. This is usually as much as may be freed without interfering with nerve supply of these muscles. This flap is then, under flexion of the elbow, fastened to the median portion of the intermuscular septum 2 inches above the elbow joint.

2. To this I added lately a corresponding incision on outer side of the arm dissecting the extensors carpi radiales, freeing them from their origin and fastening them in similar manner 2

inches higher up, to the outer intermuscular septum. It is also advisable to identify the musculospiral nerve and to retract it backward.

This operation will cause the flexors and extensors of the wrist to act as flexors of the elbow but it must be understood that the flexion power of these muscles is very limited and that only those cases should be selected in which the muscles mentioned are not or only very slightly weakened.

This method has been used in connection with arthrodesis of the shoulder or alone in ten cases, one of which is too recent to be reported. Of the remaining 9 cases:

FIG. 5
Case B. R.—Arthrodesis of Shoulder Plus Elbow Plasty.

FIG. 7
Case L. M.—Arthodesis of Wrist

FIG. 6
Case B. R.—Observation 6 and 8 Months.

FIG. 8
Case L. M.—Observation 12 Months

Average age of patients 10 years.

Average duration 3 years.

Average observation after operation 12 months.

Result: Good in 5 cases, active flexion of the elbow to or above the horizontal.

Fair (distinct muscle action) 1 case.

Poor (slight or no muscle action) 3 cases.

Patient is placed in a plaster cast for 2 months and then must wear, for at least 6 months or more, a splint with a stop lock not allowing extension over 90 degrees.

III. Drop Hand and Flail Wrist.

In many cases the question of stabilizing the wrist had to be taken up, either on account of loss of active muscle power or on account of contractures. The necessity of the extension position as well as that of stabilization in this joint is now well enough established. The advantages of a fixed wrist over a flail one will not seem strange when one remembers the splendid results obtained by stiffening operations on the ankle. In cases of flail elbow where some of the flexors and extensors of the wrist are to be made available for elbow action, stabilization of the wrist is also one of the mechanical requirements.

Technic: A short incision is made over the dorsum of the hand between the extensor pollicis longus and extensor indicis. One proceeds directly to the carpal joint without interfering with tendons or their sheaths. The joint is opened, part of the radius and of the scaphoid are scooped out. Capsule and fasciae are sutured and the wound is closed, the wrist being placed at once in a cock-up splint.

The result is not complete arthrodesis but rather very limited motion of the wrist from about 30 degrees extension to 10 degrees.

Eight cases were operated. Five paralytic and three spastic.

Average age of patient 10 years.

Average duration 7½ years.

Average time of observation after operation 11 months.

The arthrodesis held in all cases. The functional result was good in 5 cases, fair in 2 cases and poor in 1 case.

Among the spastic cases two had extreme spastic flexion contractures.

The cases are subjected to prolonged muscle educational after-treatment.

IV. Tendon Transplantation.

With the limited amount of muscle power available in infantile paralysis we found it advisable in almost all cases, before transfering power from the flexors to the extensors of the fingers, to secure first stability of the wrist by arthrodesis. Tendon transplantation to procure extension of the fingers was done in 6 cases. In 5 cases the interosseous route was used in carrying the flexor carpiulnaris forward to the extensor tendon. The flexor carpi radialis, when used, was carried around the outer side of the radius as advised by Sir Robert Jones.

Operative technic: In bringing the flexor carpi ulnaris through the interosseous space from a volar incision one should be careful to dissect the ulnar nerve and artery and retract them

Fig. 9
Case H. W.—Tendontranspl.
(Interosseous)

radially. The tendon of the flexor carpi ulnaris is brought through the interosseous membrane at the upper border of the pronator quadratus. The tendon is sutured lengthwise in two strips to the extensors of the fingers.

Six cases were operated on, the interosseous transplantation being done in five. One case died of influenza in less than one month after operation. Of the remaining five cases:

FIG. 10
Case H. W.—Observation 10 Months

Average age of patients 16 years.

Average duration 6 years.

Average time of observation after operation 12 months.

Result: Good in 3 cases, fair in 1 case and poor in 1 case.

Four cases were cases of infantile paralysis and 1 of peripheral paralysis.

In three cases the arthrodesis of the wrist accompanied the interosseous tendon transplantation.

V. FLEXOR PLASTY.

Loss of active opposition of the thumb seriously interferes with the function of the hand. If the long flexor of the thumb is active a good deal of improvement can be obtained by a simple tendon plasty. The flexor tendon is split longitudinally and the outer half is carried around to the outer side of the base of the basal phalanx of the thumb and is there fastened. Within a few weeks the point of the thumb can be brought in contact with ulnar side of the hand and little finger.

Of six cases operated three were cases of infantile paralysis, 2 of Volkmann's paralysis and one of peripheral paralysis.

Average age of patients 14 years.

Average duration 6½ years.

Average time of observation after operation 11 months.

Result: Functional result good in five, fair in one.

In most of the cases this operation was preformed in addition to other work on the hand and forearm.

VI. In a similar manner lack of extension of the thumb interferes with function of the hand in certain groups of spastic cases. The thumb not being sufficiently checked by extensor action when the fist is closed, is thrown under the fingers. In these cases use was made of the method of Mayer and Biesalski, by taking the extensor of the index finger as a check to the flexors of the thumb.

Six cases were operated. All were cases of spastic hemiplegia.

Average age of patients 8 years.

Average duration 7 years.

Average time of observation after operation 7 months.

Result good in five cases, fair in one case.

VII. Flexion contracture of the wrist in main en griffe as found in cases of spinal paralysis and Volkmann's contracture was treated by flexor plasty in some cases, and by the cock-up

FIG. 11
Case J. B. — Thumb Extensor Plasty.

FIG. 12
Case J. B. — Thumb Extensor Plasty.

FIG. 13
Case L. D.—Observation 18 Months.

splint in others. As far as the claw hand deformity is concerned no method has been found superior to that originated by Sir Robert Jones. The writer has used a short cock-up splint covering the palm of the hand.

For the correction of the hyperextension position of the metacarpo phalangeal joints, many modifications have been devised. In the spint I have been using lately the principle of traction is applied in two separate systems. One acts upon the basal phalanges to overcome the hyperextension in the metacarpo phalangeal joints and the other upon the end phalanges of the fingers to overcome the flexion contracture of the middle and end

FIG. 14
Case J. B.—Observation 6 Months

phalanx. Traction is made by means of leather straps sewed to a well fitting leather glove. The straps are fastened to sliding bars which allow more or less divergence of the traction systems. The bars are carried by an upright arising at an angle from the upper end of the cock-up splint.

In most of the cases reported a combination of operative procedures had to be carried out. It was very evident that where the operation succeeded in regard to its original purpose it also

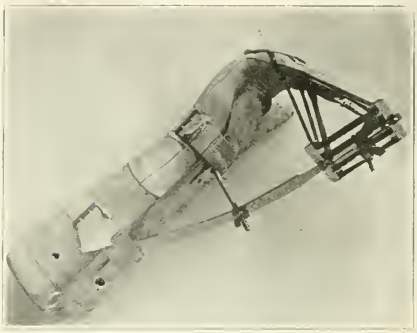


FIG. 15
Cockup Traction Splint.

FIG. 15a.
Cockup Traction Splint.

decidedly benefited action in neighboring joints. For instance flexor plasty of the elbow, combined with arthrodesis of the shoulder in three cases showed a much better functional result than in cases where arthrodesis of the shoulder was not carried out, though indicated. Likewise, the writer feels that if arthrodesis of the wrist had been carried out in several cases of elbow plasty in which it was omitted the results for the elbow would have been better.

FIG. 16
Case R. W.—Splint Treatment

FIG. 17
Case R. W.—Observation 2 Months

As far as transference of power from flexors of the wrist to extensors of the fingers is concerned the writer is convinced that, at least in cases of spinal paralysis, the best results can be obtained only if stabilization of the wrist joint in extension position is secured. In the majority of cases this can be obtained only by arthrodesis.

DISCUSSION OF DANFORTH AND STEINDLER PAPERS

Dr. Clarence L. Starr, of Toronto, said that the subject of nerve lesions and paralytic conditions resulting from them was an intensely interesting one, and it had proved one of the most serious of war disabilities. Experience would now have to be applied to civil practice. War practice was now a post mortem condition which he hoped the present generation would not have to pass through again. The proper time for operation on nerve lesions was of great importance. They were now studying results upon 450 to 500 cases of nerve suture and nerve separation from scar, and were attempting to find out what they had succeeded in doing. The results were very interesting. Early cases were those of bullet wounds and machine gun wounds, which generally healed within two weeks, but left complete separation of the nerve. These were operated on early and formed a large percentage of complete recoveries and restoration. Others that were found to be septic and were brought home for treatment 18 months or 2 years after the injury, showed a very small percentage of recovery, so that they were almost hopeless. One had to choose the best time to operate. Dr. Kidner at the A. M. A. said that a large percentage of these men would recover if left alone, but many of them would not come anywhere near approximation, even if left till the crack of doom. Dr. Kidner placed emphasis on Tennell's sign. The speaker said he was not sure that this was a good sign. Irritation of the proximal end often would cause a tingling, also irritation of the nerve distal to the injury, would cause formication, in cases with widely separated ends, so that the sign was not altogether reliable. Operation should not be delayed when it was found that the muscle power was doing down, as tested by faradic and galvanic stimulation. Operation done with these indications usually showed what was expected. The orthopedic man worked hand in glove with the neurologist, and insisted on his checking up results to ensure accuracy. When one read such accounts as those which stated that 12 to 16 inches of nerve gap had been bridged over, with recovery, one could only say that the writers were a very high grade type of what the men in the ambulance service called "liers." The speaker had never seen a satisfactory case of nerve bridging, with ultimate recovery. The question of bringing end to end in nerve operation was very difficult. One could get recovery in nerves with purely motor function like the musculo-spiral and the sciatic. It seemed occasionally as if there were rotation of the nerve and that the axis cylinders found their way from motor areas to sensory areas. Elsberg had described such types of bundles in the distal end of the nerve, and showed that one could pick out fasciculi in the upper end and compare them with those in the lower end. A piece of shrapnel might twist a nerve a number of times, and it was almost impossible to get approximation of the proper fibers. One had to trust in the Lord and join the ends. Best recoveries were seen in the sciatic, the median and the musculo-spiral. In the upper extremity one had a good substitute in muscle transplantation, particularly in the musculo-spiral, where one only had to overcome gravity. With the musculo-spiral injury one could transplant muscles and make a useful hand. The pronator radii teres could be taken from its insertion and inserted into the extensors of the wrist, the palmoris longus to the extensors of the thumb, the flexor carpi radialis to the extensors of the fingers, through the fat and subcutaneous tissues. Recoveries in two months were almost equal to recoveries of the musculo-spiral in eight or ten months. Pictures would show voluntary extension of the hand, wrist and thumb. The question was not so much what had been done, as what was the final result. Tendon transplantation was so satisfactory, that one did not feel badly if the musculo-spiral was separated. The slides would show the method of tendon transplantation.

Dr. Sidney M. Cone of Baltimore said he had prepared a paper on the diagnosis and prognosis of peripheral nerve injuries. Most of his material had

a bearing on what had been said. To combine all in a critical review would be best done by referring to the Journal of the A. M. A. May 24th, in which J. S. Horseley reviews biology in its practical application to surgery. He emphasized the necessity of co-operation between the laboratory worker, the surgeon and clinician. There is no doubt that "team work" in surgical, orthopedic and neurological fields would aid greatly in solving the problems. Cone thought that some things had been too emphatically said. He noted Col. Starr's statement that one could not successfully graft peripheral nerves. There was a good deal of good clinical and laboratory work which would refute that broad statement. The work of Nageotte had to be considered, with some reserve on the surgical side, but he had shown that nerves could be successfully united. He used live and "fixed" nerve between the ends, and ultimately decided that nerve preserved in alcohol made the best graft. One should keep one's mind open at the operating table, and learn more about how nerve grows and what appearances indicate. The speaker said he studied 500 cases at the Alderhey Hospital and in the laboratory of the University of Liverpool. Captain Alexander would add his clinical findings to the work, so that the link between the clinical, the surgical and the laboratory work could be established. The anatomical changes both microscopical would then be better appreciated. Although a great deal of work had already been done on this subject, the speaker said he was not ready yet to make any dogmatic statements, such as had apparently been deduced from his writings. He believed that there were other methods of nerve growth than those commonly seen, i. e., from the central end. He had no doubt that the proximal end, surrounded by Schwann's sheath cells, had a better chance to grow. He felt also that nerve formation might take place in the distal ends or the scar formation of Déjérine. There was good reason why there should be more growth from the proximal end, than from the distal end of it retains connection with the trophic center. How then did the nerve find its way to the periphery? A plea should be made for a more complete study, with open minds, upon this subject. Nerves caught in a cellular embryonic state might produce growth which simulated per primam growth. Growth under pathological conditions is different. Often nerves had been seen showing wild growth through the sheath after operation. Scar tissue, however, prevented this. Even with foreign bodies, symmetrical nerve bulbs were seen, growing quite close up to the foreign body. There was also the question of the blood supply to the nerve. In a case where the musculo-spiral and ulnar nerves had been completely severed for months, the amputated arm was studied, and a growth of new nerve was found down to the wrist, not complete, but a suggestion of an attempt to form new nerve all the way along and some adult nerve with funnels. In another case nerve callus was seen, and a half inch above the site of operation for severed tendons. In following it down, he found the median nerve half cut through. Recognition of the pathological material led to a proper interpretation of the clinical condition.

Dr. S. L. McCurdy said that he had placed himself on record in the paper read before this society two years ago upon the subject of musculo-spiral surgery. Since that report a number of cases have presented themselves in which the brachial plexis or its branches had been injured. These cases may be grouped as follows:

First, fracture of the elbow joint resulting in contractures of the forearm, in which tendon transplantation gave satisfactory results. This was done in two cases.

Second, fracture of the skull with brain injury followed by wrist drop. Complete recovery of the peripheral defect followed repair of the brain.

Third, axillary dislocation of the head of the humerous in two cases, resulting in complete paralysis of the extremity. In both these cases improvement began in about five months, and at the end of a year had recovered satisfactorily, with the exception that there still remained a great deal of pain throughout the extremity.

Fourth, wrist drop following machinery accidents in three cases, in which

the Jones cock-up splint was worn and regeneration of the nerve occurred uniformly after a lapse of about eight months.

Two additional cases of obstetric paralysis have been observed, both of which recovered with the hands placed in normal position.

To me the most important point in the early treatment of these cases is immediate operation to be sure that the nerve is not entirely torn off, and suturing, or other reparative operation should be carried out. The second essential in the treatment is that if the injury has occurred several months previous to observation then care should be taken to hold the extremity in a normal position until regeneration has occurred, so as to avoid troublesome contractures, which always require additional operative procedure and may be avoided by following the above rules.

Dr. Frederick C. Kidner, of Detroit, said that there were certain things in nerve surgery which were similar to questions that came up in fractures. In considering nerve injuries men were not willing to give sufficient time to the nerve; the cases were watched for three or for six months, and then it was assumed that recovery would not take place. That was essentially wrong. Experience in England in 1917-1918 in nerve suture, showed that recovery rarely occurred in twelve months, but since leaving England, news had come that about 70 per cent of the cases had recovered in longer periods. It is therefore important to give plenty of time for nerve regeneration before using other methods such as tendon transplantation to overcome disabilities from paralysis. Recovery had been seen of nerves which supply small muscles, that is ulnar, median, posterior tibial, etc. The speaker had not seen recovery where a nerve graft had been done, although such cases had been recorded. The operative side of nerve surgery, he thought, had been unnecessarily condemned. It did not seem necessary to wait long periods of time before operating on nerves. Usually it was safe to operate early by a two-stage method. One could go in within two or three weeks after the skin had closed and find out what the condition was surrounding the nerves. Then one could sew up and watch for sepsis, and if none appeared, finish the operation. That would save the patient six to nine months of waiting. The preliminary operation did not do any harm. Badly damaged nerves often did not need operative interference except removal of bands of scar tissue. Badly crushed and scarred nerves recovered surprisingly well. But several nerves, the earlier suture was done, the better the prognosis. It was almost impossible to tell whether the nerve was severed or not. By waiting to find out, time was wasted. One had better go in and explore. The simpler the operation the better. One sometimes found cases of interposed foreign body, muscle or membrane, actually preventing the union of nerve. This should be removed, and the ends brought together in an easy position with the finest silk suture. The nerve should then be replaced in the best bed it was possible to find, with relaxation of the suture line by manipulation of the joints in the neighborhood. It was better to wait for nerve recovery rather than do tendon transplantation, which gives good result for four or five months, but rarely permanently. In injuries of the musculo-spiral, the hand will adapt itself and become useful in an extraordinary manner. Therefore it is seldom necessary to do complicated and difficult operations. A case was cited of a medical man, a laboratory technician, who had had musculo-spiral paralysis twenty years, with wrist drop, yet he could use the hand almost as well as a normal hand. When there is any doubt about complete division of the nerve, no external examination will positively clear up that doubt. It is therefore unwise to wait in doubtful cases. It is better to operate as soon as active sepsis has ceased. If operation showed any continuity whatever, resection should not be done, but the nerve left alone. Often such nerves recover spontaneously. One man with a suture of the sciatic in 1914, began to recover in 1917, and in 1919 he was still improving. A musculo-spiral which was given up after eight months, but was let alone fortunately, had complete recovery at the end of two years. If there was any fibrous continuity, the nerve would push through. Often at operation one could get a strong electrical response from tissue which

looked like nothing but scar tissue, which proved that there were nerve fibers coming through. Even if there were no electrical reaction it was well to err on the safe side.

Dr. A. H. Cilley, of New York, said that we learn through our own and our friends' failures. Our British friends have been having theirs, and by next year we shall be having ours. One point in doing a nerve suture is to be sure that nerve is sutured to nerve and not to a tendon. In a case near Glasgow, Mr. Kennedy found that the first operator had united the Median nerve to the Palmaris Longus tendon. It is unnecessary to say that the result was not good either as a nerve or tendon suture. In regard to what Col. Starr said about twisting of the nerve fibers; it is possible to get a complete mixup when the nerves are mixed up. One patient operated upon in Glasgow showed conflicting sensation chart, and at operation it was found that the median and ulnar nerves had both been severed, and the proximal end of the ulnar was not united to anything except scar, and the distal portion of the median was the same. The distal ulnar was united to the proximal median and the chart surely was mixed.

In regard to Dr. Cone's point about nerve growth, Kennedy felt that growth took place both ways. Now Dr. Cone seemed to partially agree with this, though at first he thought Dr. Kennedy wrong. What Dr. Danforth said was true about immobilizing the joint above the hand. One knew what happened with hot axles, and a stiff hand was in position of a hot axle. One had to grease the axle.

Dr. R. Hammond of Providence R. I. said that he had visited all the orthopedic centers in the British Isles and the universal feeling was that nothing but end to end suture of healthy nerve fibers would produce growth. Lateral implant was tantamount to failure It was considered that the best work was being done in the clinic of Sir Harold Stiles. The speaker agreed with Dr. Danforth that the voluntary power of the muscle was a more accurate test than electrical reactions.

Dr. J. Torrance Rugh of Philadelphia said that he wished to emphasize two points in Dr. Steindler's paper. Splints with pressure should be applied extremely carefully as the dorsum of the fingers would not stand much pressure. Cases returning from Europe had been seen in which arthrodesis of the shoulder joint had been secured in a position of 40 degrees of abduction. In one man great fatigue and distress was caused by this ankylosis. He had free use of the scapula, but the arm was tired. An angle of 20 degrees was much better.

Dr. Winnett Orr of Lincoln, Nebraska, said he had seen eight cases of ankylosis of the shoulder with loss of the head of the humerous. A fixed abduction position of 40-45 degrees was necessary for a final result. Twenty degrees was not enough.

Dr. E. W. Ryerson, of Chicago, said that it was not yet absolutely established that any method of filling-in gaps between the ends of severed nerves is uniformly successful. Huber, of Michigan, thinks that the sciatic of a young calf can be used. It is of great importance to develop a universal technique, since there are a great many cases which need to have defects bridged over. The method of turning down a flap from the nerve is entirely illogical, and cannot succeed. In some instances it may be wise to adopt the French method, and resect the bones a sufficient distance to allow end-to-end union of the nerve. A hand without the median or the ulnar nerve is seriously disabled. Large gaps in the sciatic may be taken care of by flexing the knee, and to a more limited extent in the region of the elbow, the postural approximation is of much assistance.

Dr. J. Torrance Rugh of Philadelphia said that in the experimental laboratory the anterior crural nerve had been resected and the sciatic transplanted. The anterior crural was re-established and not the sciatic.

Dr. A. H. Cilley of New York said that in ankylosing the shoulder, it should not be fixed at right angles to the body, but in about 60 degrees of abduction with the elbow anterior to the lateral plane of the body so that the humerus would make an angle of about 45 degrees with this plane. This position allows the man to bring his hand to his face, and at the same time does not put undue strain on the Trapezius when the arm is allowed to hang at his side.

Dr. H. P. H. Galloway of Winnipeg said he could speak enthusiastically of tendon transplantation in those cases of musculo-spiral paralysis in which there was no hope whatever of restoring nerve power to the extensor muscles.

Col. Clarence L. Starr, of Toronto, said that he wished to correct a wrong impression, in regard to bridging of gaps. He had stated that he had never seen a case in his own experience in which the bridge had been successfully done in war surgery. He was not speaking of the literature. No tendon transplant was ever done except in cases of irreparable nerve lesion. It was known at time of operation that it was impossible to recover the nerve. The technic of tndon transplantation had to be properly understood and carried out, or the tendon would slip.

Dr. Murray S. Danforth of Providence, R. I., in closing said that he put Tinel's sign last because of the variations found in it. They did find, however, that making the test by going from a distal point proximally and taking careful measurements certain information could be gained which seemed of value. In some cases where a transplant had been made to fill a gap in a nerve it was found that this sign progressed downward through the transplanted section to the point of suture of the transplant to the distal portion of the nerve. Here it stopped. In these cases it was the intention of Colonel Stiles to explore this point.

In regard to tendon transplantations, the results seen had been satisfactory. For musculo-spiral paralysis the transplantation used was the flexor: carpi radialis into the extensor ossis metacarpi pollicis and the extensor brevis pollicis, the palmaris longus into the extensor longus pollicis, the flexor carpi ulnaris into all the finger extensors, and the pronator radii teres into the extensors carpi radialis longior and brevior. Beginning about one month from the date of operation the patients were put into the curative workshop to train the muscles. During the first weeks of work the wrist was protected by a short cock-up splint.

Dr. Arthur Steindler in closing said that there should be no mistake about which tendons should be transplanted in arthrodesis of the wrist. Wrist drop could be nothing but a hindrance to the function of the hand. The actual muscle power was shown to be decreased 75 per cent by relaxation. Before securing power for the extensors of the fingers one should first take care of the stabilization of the wrist. The flexor carpi ulnaris was used to transfer power to the fingers. Its action co-ordinated with forceful extension movement of the fingers. Arthrodesis of the shoulder is applicable even to younger patients. The triceps is the main stabilizer of the shoulder joint. Even where Deltoid paralysis is present the patient can, by triceps contracture press the humerus firmly into the glenoid cavity and then abduct the arm with the shoulder blade by contraction of the trapezius.

In regard to re-establishment of nerve elements over gaps, I will say that, in experiments of neurotizarion of paralyzed muscle it was shown that it was possible for peripheral nerve, implanted into the muscle, to branch out into it, and the muscle was then capable of being stimulated by the Faradic current. There were also histological changes of the muscle cells; such as regeneration with reappearance of striction, synchronous with the regeneration of the nerve. "I have not been able to find the actual motor end plates, that may have been due to insufficient technic."

TRANSFERENCE OF THE FIBULA AS AN ADJUNCT TO FREE BONE GRAFT IN TIBIAL DEFICIENCY.

BY WILLIS C. CAMPBELL, M. D., MEMPHIS, TENNESSEE

REPORT OF THREE CASES:

When from any cause, gun shot, shell wound, osteomyelitis, congenital or tumor, there is a deficiency in the shaft of the tibia, the leg deviates inward with inward rotation of the lower fragment. This leverage on the upper tibio-fibular joint causes gradual relaxation of the ligaments, resulting finally in luxation with marked prominence of the head of the fibula. The limb can be made straight by passive movement, and a steel brace is essential to weight-bearing, but this may be difficult to adjust on account of the projecting and unstable head of the fibula with the varus tendency of the leg.

In 1905, Huntington severed the fibula on a level with the lower end of the proximal fragment of the tibia, and transplanted the distal fragment of the fibula into the proximal fragment of the tibia. After bony union the same process was repeated at the lower fragment. This proceedure is in reality a two-stage transplantation of the shaft of the fibula, leaving the upper and lower extremities unattached and physiologically inactive.

Stone, in 1907, modified the second stage of the Huntington operation by splitting the shaft of the fibula at the lower fragment of the tibia, leaving one half continuous with the outer malleolus, preventing valgus at the ankle. The other half is attached to the lower fragment of the tibia. In more recent years, with the advent of the bone graft the Huntington and Stone operations have been discontinued, as the free graft is both anatomically and physiologically correct, though not so certain of success. When the free graft, or even the Huntington method does fail—which may be rare—the condition of the limb is not improved and may be rendered more disabled.

In order to make success more certain I have transferred the upper extremity of the fibula as an adjunct to the bone graft; the technique of this proceedure is as follows: An incision in the skin about four inches in length is made over the lateral aspect of the head of the fibula, the deep fascia is incised, then the capsule

of the tibio-fibular joint. All cartilage and fibrous tissue is removed from the head of the fibula, being careful not to injure external popliteal or peroneal nerves. Next, a cavity is made in the inferior and external aspect for the reception of the denuded head of the fibula. Heavy traction will place the head of the fibula within the cavity, provided scar tissue between tibial fragments does not prevent. When such difficulties arise these tough bands are excised or severed, the periosteum of the fibula is sewed to the periosteum of the tibia and the wound closed with cat gut throughout. As the final step, we proceed to do the inlay graft in the usual manner, which needs no description.

This method has been employed in three cases, which give the following history:

CASE 1: White, Male, Age 17. In November, 1917, received a load of squirrel shot (November 6) at close range through the

CASE 1 (A)
Deficiency in tibia from gun shot wound. Note dislocation of fibula with loose flail tibio-fibular joint.

CASE 1 (B)
After transference of fibula and free bone graft in defect, gain in length of about one inch.

upper third of the left libia, tearing away four inches of bone; was first seen August, 1918, when there was 2¼ inches shortening. A sinus persisted, surrounded by pale granulations on the anterior aspect. The skiagram showed a small sequestrum in the upper fragment. The head of the fibula was prominent, subluxated with a loose flail tibio-fibular joint, adding much to the disability; the leg deviated inward with an inward twist of lower fragment. At this time the sequestrum was removed, when healing was uneventful. Oct. 2, 1918, the head of fibula was transferred as above described, and a plaster cast applied. Nov. 20, 1918, cast removed, and much to my surprise the limb was solid, false motion could not be detected, the tibia and fibula above being firmly united. On account of previous infection free graft was delayed until Jan. 15, 1919, which was accomplished from the opposite tibia in the usual routine manner. After this, patient was not seen until May 20, 1919, when on removal of cast bony attachment at both

Case 1 (C)
Front view four months after operation.

Case 1 (D)
Side view.

ends of the graft appeared solid. Skiagram shows graft in position and the formation of new bone about the graft. Measurement at this time shows a gain of 1¼ inches in length. A simple steel brace was applied and should remain about four months.

CASE 1 (E)
Showing stability of limb.

CASE 2: White, Male, Age 27. Absence of bone in lower third from osteomyelitis right tibia as shown in illustration. Jan. 3, 1919, operation completed at one sitting; transference of head of fibula and free bone graft from opposite limb to bridge defect. On account of scar tissue considerable dissection was necessary with removal of tough fibrous bands before the bowing and inward twist could be overcome. Following the operation there was sloughing of superficial scar tissue, but no infection. At the end of eight weeks cast was removed, bone appeared solid at all points; skiagram presents a complete bridge of bone. Patient returned to his home with wound practically healed on May 19, 1919.

CASE 2 (A)
Showing dislocation of fibula.

CASE 2 (B)
Showing head of fibula transferred.

CASE 3: White, Female, Age 17. Absence of bone in lower third left tibia from osteomyelitis at the age of 9. On April 20, 1919, same proceedure with the exception of osteotomy of fibula to correct bowing—recovery has been uneventful, all wounds healing by first intention.

CASE 2 (C)
Showing closure of defect after free graft.

The advantages of the procedure are:

1st: It is possible to lengthen the limb 1¼ inches.

2nd: Early transference of head will stabilize limb and prevent shortening.

3rd: At the end of eight weeks we have a stable limb in which no false motion is possible between knee and ankle.

4th: Early stability prevents motion and facilitates the development of the free graft.

5th: New blood supply is added to the tibia through the medium of the fibula, promoting nutrition.

6th: Greater chances of complete success.

There is only one point that I especially desire to emphasize, and that is a two-stage operation should be done in all cases where there is much difficulty in making the limb straight from contraction of dense scar tissue. Most patients will readily submit to the second operation when such marked improvement follows the first.

Sufficient time has not elapsed to consider end results, but the improvement has been so pronounced that a preliminary report of these cases with detailed description of procedure might be worth while at the present time when we are confronted with similar conditions from wounds incurred during the recent conflict.

References:

Albee; Bone Graft Surgery.

Davison and Smith; Autoplastic Bone Surgery.

Huntington, T. W.; A Case of Bone Transference. Ann. Surg., Philadelphia, 1905. xli 249.

Stone, J. S.; Partial Loss of the Tibia Replaced by Transfer of the Fibula, etc. Ann. Surg., Philadelphia, 1907, xlvi 628.

BRITISH ORTHOPÆDIC ASSOCIATION.

Annual Meeting, November 14th, 1919.

London.

PROGRAMME.

At the rooms of the Medical Society of London,
11 Chandos St., W. 1.

9:30 a. m. Executive proceedings.
Treasurer's Report.
Election of new members.
Election of Officers for 1920 and 1921.

10:00 a. m. President's address.

10:30 a. m. Discussion on "Cineplastic amputations."
Opened by the President.
Discussion continued by: Mr. T. H. Openshaw, Mr. S. Alwyn Smith, Sir J. Lynn Thomas, Mr. F. J. Fitzmaurice-Kelley (by invitation).
Injuries of the crucial ligaments, Mr. W. H. Trethowan.

2:15 p. m. Birth paralysis.
Discussion opened by Mr. H. A. T. Fairbank and Mr. Harry Platt.
Candidates theses.
The operative treatment of spastic paralyses, Mr. A. S. B. Bankart.

The Association Dinner will be held at 7:30 p. m.

On Saturday, Nov. 15th, Hospital demonstrations will be arranged by certain of the London members.

Mr. D. McCrae Aitken will arrange a visit to the Country Hospital for Cripples at Pinner for members and visitors.

Current Orthopaedic Literature

Injuries to the Back. By James O. Wallace, M. D., Pittsburgh. *Pennsylvania Medical Journal*, Vol. XXII, July, 1919, No. 10.

Injuries to the back may be broadly divided into four classes: (1) Contusions; (2) Sprains; (3) fractures, (a) without cord involvement, (b) with cord involvement; (4) dislocations. Of these conditions I will discuss only two, viz: sprains and fractures without cord involvement occurring in the lower back.

The human body maintains its upright position by means of a system of curves, which are the result of muscular action working against the force of gravity. We have a flexible weight-bearing column attached in unstable equilibrium to the pelvis, through the sacroiliac joints. Nature always fits the part to do the work it is destined to do so we find in studying the muscles of the body that the posterior muscles are much superior to the anterior flexors of the body, the balance being maintained by the posture of the body and the weight of the abdominal and pelvic viscera. In the lumbar region, motion is more extensive on account of the relatively large portion of elastic intervertebral substances, because of the direction of the articulating surfaces, and because the spine is nearer the center of the body. This portion of the spine is the seat of more fractures because we have a freely movable portion passing into a fixed dorsal region and the sacrum below.

The sacroiliac joints situated as they are at the end of the spine on the one hand, and connecting the spine with the pelvis on the other hand are subject to tremendous strain at all times, and it is not surprising that they are commonly subject to sprains, being so intimately connected with one another that to all intents and purposes the symptoms may be discussed together.

The lumbosacral joint consists of the movable fifth lumbar vertebra, working upon a fixed base of the sacrum. The physiological inclination of the pelvis (50 to 60 degrees) places this joint at a great disadvantage, and whenever abnormal posture is maintained, the weight and leverage at this joint subject the ligamentous attachment to tremendous strain. Besides the fifth lumbar vertebra is subject to more anomalies than any other part of the spine.

Sacro-iliac Joints.

Recent investigation showed that the sacroiliac joint possesses all the histological structures of a true joint. It possesses a certain amount of motion which has been accurately measured in the laboratory, and by the obstetrician in practice, as demonstrated by the Walcher position. The sacroiliac joint has an ear-shaped articulating surface of irregular contour, is almost vertical in position, contains hyaline, cartilage and synovial membrane and its surfaces are bound together by anterior and posterior sacroiliac ligaments which are ligaments of the strongest variety, the posterior being the stronger of the two. In front of the sacroiliac joint lies the lumbosacral cord and sacral plexus,

which gives off branches to the pelvic organs and lower extremities. The sacrum moves either forward or backward through the third sacral segment. It plays an important role in hyperflexion and hyperextension of the trunk upon the pelvis. In considering the functions of the sacroiliac joints it is well to look into the muscles which control this function. The posterior musculature, which has to do with this motion may be divided into (a) an upper and (b) a lower group. The first consists of the erector spinae with its tendinous attachment into the sacrum below; the second, the glutei and hamstrings, which are attached to the ilium and tuberosity of the ischium. The principal function of the lower group, when acting from a fixed point below, is maintaining the balance of the pelvis upon the head of the femur and in further contraction producing hyperextension of the trunk.

Baer classifies sacroiliac strain into two classes: Class A, in which the superior border of the sacrum travels posteriorly, producing the flat back type; Class B, in which the superior border of the sacrum tilts forward, producing the hollow back type.

Symptomatology.

In the traumatic variety we have a history of a mild or severe strain, generally with the body in an awkward position. The pain may be simply an ache, occurring in the lower back, or it may be so severe as to totally incapacitate the patient. The pain is so great at times that any motion causes pain, especially bending to the front or to the side. At times a patient when turning around, will lift his limb with his hands. Pain is usually indicated at the sacroiliac joint, over the center of the sacrum, or at the base of the ribs. It may be referred to the crest of the ilium, to the front of the pelvis and down the thigh even to the calf and the heel, according to the portion of the nerve involved. As a rule the pain in the beginning is not referred down the limb, especially in mild types, but in an acute severe type, the pain may be referred from the very onset down the leg.

There is limitation in forward bending and side bending toward the affected joint. The pain is also complained of at the base of the ribs. This can be explained by the origin and insertion of the erector spinae muscle, pain at origin may be referred to insertion of the muscle. Kernig's sign is positive, producing either pain at the joint or at the insertion of the hamstring at the knee.

Radiographs.

A radiogram usually helps in its negative findings in ruling out disease, although you occasionally get a lipping of the lower limits of the joints which is the result of a hypermobility.

Treatment.

In the traumatic type, treatment depends on the severity of the case. In mild cases an adhesive strapping about 2½ inches wide, applied midway between the crests of the ilium and the trochanters, passing through the third sacral segment, is applied. Whether this dressing acts as an annular ligament to the glutei according to Lovett, or fixes the joint according to most other men, it relieves the symptoms as long as it is taut. In more severe cases in which the simple measures have failed, manipulation is the method par

excellence, because as in any other joint in the body where we have an inflammation, whether it is traumatic or inflammatory, the muscles go into spasm and protect the joint. This manipulation is done with the patient on his back by means of flexion of the extended limb over the abdomen until the foot at times almost touches the chest. This manipulation must be done thoroughly until the muscles are absolutely relaxed. Afterwards the patient is put up in a long plaster spica from the nipple taking in one knee. Care must be used to keep the lumbar spine in its normal curve and at times adhesive strapping applied before the cast is applied is very beneficial. The cast must thoroughly hug the body. Some men use only the body cast, taking it well below the hips. It has been our practice to use a long spica and by this means we get our patients up on their feet in 24 to 36 hours and then get them home. They wear this cast anywhere from 2 to 6 weeks according to the severity of the symptoms and the urgent needs of the patient. After the cast is removed they are given proper support, men a corset with two bars which fit in well to the lumbar region. The corset helps to keep the proper posture and protects the patient from undue strain on the back.

General Considerations.

Mild sprains often repeated produce a chronic condition with adhesions and contractions of the posteroir muscles. The lumbosacral joint is also the seat of sprains, and a dislocation of the posterior inferior facet of the fifth lumbar vertebra is not rare.

Symptoms.

Patients may not stand erect but sometimes after temporary inability, they get up and are able to go home, often they remain at work. Pain, tenderness, muscle soreness, rigidity and a flexed position of the spine are the symptoms in these cases and they are most often treated for contusions and sprains of the back. After getting out of bed if they have been confined, the rigidity of the spine does not disappear. They still complain and in a short while a kyphosis appears and then a roentgen ray is taken and the proper diagnosis made.

Diagnosis.

Most of these cases are hard to differentiate without the aid of the roentgen ray and in these cases none but the most competent man should attempt to ray the back. Where the body of the vertebra is fractured a side view is essential to give you the proper detail.

Treatment.

The immobilization in plaster cast or efficient brace for six months to year will prevent deformity and allow repair to take place except in the most severe cases when more than one vertebral body has been crushed, when the author believes the best results will be obtained by means of a bone transplant into the spinous processes and in these cases a plaster jacket or brace should be worn for at last six months to a year or longer or until the back is strong.—*Leo C. Donnelly, Detroit.*

NOTES ON RE-AMPUTATION... By A. E. Chisholm, F. R. C. R., Edinburgh, Late Captain R. A. M. C. Edin. *The British Medical Journal*, July 19, No. 3055.

SOME REASONS FOR RE-AMPUTATION.

1. Adherent scar with weak or partial healing. If the scar is terminal, and especially if adherent to bone, it is apt to become irritated by pressure of the artificial limb. If lateral and adherent to the bone near its end, there is apt to be trouble from dragging. Such scars may break down. "A large or a small adherent scar is not necessarily an indication for re-amputation. Many cases with an adherent thin scar do well,—better than they would with a better scar and a shorter stump. It is when the stump is conical and has a large terminal scar or ulcer that a re-amputation may become necessary."

2. A chronic granulating surface, especially if terminal and near the end of the bone, is very likely to lead to weak and unsatisfactory healing, with adhesions to the end of the bone, or healing may fail altogether.

3. The presence of sinuses. Huggins says: "No aseptic operation should be performed on a stump until all sinuses have been healed for two or three months." I hesitate to express an opinion contrary to one with so large an experience, but I think that at least in cases with very mild sepsis in the sinuses, much time may be saved and a good result obtained by re-amputation, provided certain precautions are observed.

4. Sequestra. It is usually wiser to re-amputate than to be content with removal of the terminal sequestrum; time will thus be saved as the separation of the sequestrum alone be performed, the resulting end of the bone is likely to be irregular and ill adapted for weight bearing.

THE OPERATION.

1. Avoid a terminal scar.

2. It is rarely wise or necessary to include muscle in the flaps. A good fibrous pad is formed between the skin with its integuments and the sawn end of the bone.

3. Re-amputate clear of the disability for which re-amputation is being performed, and try to make sure that no further operation will be necessary. The object of re-amputation is to get a good, sound, serviceable stump. It is far better to sacrifice a little extra bone, provided it can be spared, than to risk a poor result with the possibility of yet another re-amputation having to be performed some weeks or months later, just because the operation has been too close to or within the danger zone. The flaps should be cut clear of the scar unless there is some real reason in a special case against such a procedure. The scar especially should be avoided if there is slightest suspicion of sepsis.

4. Re-amputation should not be performed in the presence of an active sepsic wound. Healthy granulation is not a contra-indication, but a realy septic granulation surface should be considered a danger signal. The folly of hastening matters in such cases has been proved.

5. If the wound fills up with clot—example, after a reactionary haemorrhage, it is well to open it right up under a general anaesthetic, clear out the clot, re-suture and drain in the usual way. Otherwise there will be great risk of a septic state ensuing.

6. If skin is scanty, and if it is important to preserve the length of the stump with a view to future function and fitting, extension may be applied by means of glue or strapping stretching from the stump to some form of wire splint. This may be in use for days or even weeks prior to operation, and a considerable gain may be achieved.

7. In amputation a short distance below the knee it is well to apply a posterior splint before the patient comes out of the anaesthetic, for there is a great tendency for the knee to assume the flexed attitude of rest, and, if convalescence be delayed, a certain amount of contracture of the hamstrings, often difficult to overcome, may take place.

8. If sepsis appears in a mild form after operation, fomentations or Carrel's treatment may be applied for a few days.

10. In amputations below the knee the anterior edge of the tibia should be bevelled so as to prevent the sharp edge from pressing on the anterior flap. It is important also to divide the fibula about a quarter of an inch higher up than the tibia, otherwise fitting of the artificial limb will be interfered with. According to Huggins it is important to preserve the interosseous membrane so as to prevent outward displacement of the fibula.—*Leo C. Donnelly, Detroit.*

Reports on Cinematic Amputations Based on a Visit to Putti's Military Clinic in Bologna, Italy. By J. A. Gunn, Col., C. A. M. C., and W. E. Gallie, Major, C. A. M. C. *The Canadian Medical Association Journal*, Vol. IX, No. 8.

The cental idea of Putti's work on amputations has been the restoration of the greatest possible amount of the destroyed functions, and the masking of the deformity so effectively that the patient no longer will be an object of pity, nor a victim of his own sensitiveness to appearing in public. These ideas have been put into practice by supplying the patients with artificial limbs which most closely resemble in appearance the normal members, and which are activated by the contraction of those muscles which formerly produced the movements of the amputated limbs. When it is impossible to use such muscles, owing to the position of the amputation, other groups of muscles are employed to supply the necessary motive power, and the patient is subjected to the necessary training to enable him to develop skill in the movements. In the case of amputation of the forearm there is every possibility of employing the principle successfully, as here the muscles which formerly moved the hand and fingers are still present, and if these muscles can be successfully connected with movable parts of the artificial hand, movement and power will be restored which will be under the same neuro-muscular control as under normal conditions.

That the principle is correct both in theory and practice has been most conclusively demonstrated to us. We had an opportunity to see between fifteen and twenty cases in all stages up to three months after operation, upon which cinematicization had been performed. The technique of the operation is exceedingly simple and is exactly as described by Putti and Dalatala in their publication on the subject. The wound is healed in from ten days to two weeks, although a small superficial granulating ulcer sometimes persists for a

week or two at one end of the tube of skin which passes through the loop of tendon. As soon as healing is complete the patient begins to practice contracting the muscles against resistance and within two or three days has developed a power which is remarkable. This power rapidly increases with practice, and within six weeks has reached its maximum. We saw several cases which had a direct traction power on the stirrup which was passed through the tendon loop.

About four weeks after operation the patient is supplied with a temporary artificial hand with which he practices the movements. In this way he develops both power and skill. In the meantime his permanent hand is being made. This consists of a socket and a wooden hand. The socket is exceedingly light and the cumbersome leather corset which usually encircles the arm above the elbow is dispensed with and replaced by a perfectly fitting vulcanite covered metal ring, placed just above the condyles. The wooden hand is similar to those used in various mechanical arms, except that it is very simple. The thumb is stationary and the fingers are joined and movable.

These fingers are connected by means of a strong cord with the rod which rests in the tunnel through the tendon and so respond to contractions of the muscles. A light spring causes the fingers to open moderately when the contraction ceases.

Another important feature of the cinematic treatment employed at Bologna, is the utilization of any rotator power that may be present in the forearm to mobilize the artificial hand. If the amputation is below the insertion of the pronator teres, the patient has strong power of rotation unless the extremities of the bones are fused, or caught in a dense scar. Should such a misfortune have occurred, the first step in the cinematic operation consists of freeing the ends of the bones so that rotary movements will be possible. This rotator power is then utilized to produce rotation of the artificial hand, in addition which is of considerable value, and which is not at present in any of the mechanical hands. The movements are transmitted to the hand by means of a cup which compresses the end of the stump antero-posteriorly, and is connected to the hand by means of a metal rod.

The success of making use of movable stumps or irregularities has led Putti to provide such motors by operative means. We saw one case in which the end of a forearm stump had been converted into two short finger-like processes which acted somewhat like a lobster's claw. By a special mechanical device these processes were utilized to move the fingers of the artificial hand. In other cases the motors are fashioned in the form of pedunculated knobs, around the neck of which are fastened vulcanite covered metal collars which communicate the movements to the fingers. But whilst this method of cinematicization is satisfactory in some cases, we gathered that the operation is difficult, and the result not always certain. The application of the power is not so direct as in the method of tubulization. We are of the opinion that the plan is unlikely to become popular.

By granting the failure of the method to satisfy the high hopes of its chief advocate, the success of the effort has been so great that it is deserving of the highest praise, and of its immediate wide-spreading emulation. It offers

to every man, even the ordinary laborer, the possibility of improving his condition that he is to a great extent relieved of the constant irritation which the loss of an arm causes in ordinary everyday life. Whilst it is not likely to increase the ease with which the farmer, or others who engage in heavy manual labor, can do their daily work, it at least does not lessen their ability to do this work, as the heavy hooks and clamps which are necessary in such occupations can be worked during working hours just as if no cinematic operation had been performed. And even among this class of men, the advantage of being able to write, to act naturally at table, to handle small objects and generally to conduct themselves while off work in a manner which closely resembles the normal, must be admitted to be very great. To the great majority of those who have lost an arm and who will, in the future, be found in shops, in offices, in professions and elsewhere where manual dexterity is not the greatest essential to their earning a living, cinematicization will prove a boon which it is impossible to overestimate. And finally to those who have been so unfortunate as to lose both arms, there is no question that the cinematic treatment will immediately change their lives from absolute dependence to comparative freedom and happiness.—*Leo C. Donnelly, Detroit.*

The Policy and Program of the Physical Reconstruction of Disabled Soldiers of the United States Army. By Frank Billings, M. D., Chicago, Ill. *The New York State Medical Journal*, Vol. 19, August, 1919, No. 8.

Physical reconstruction, as it is now defined, is recognized as the continued management and treatment of the sick and wounded disabled soldiers carried out to the fullest degree of maximum physical and functional restoration consistent with the nature of the disability, by the employment of all known measures of modern medical management, including physio-therapy, manual and metal work, recreational play and military drill.

The division of physical reconstruction in the office of the Surgeon General was organized with a director responsible for the administration of the work. Subsections were organized on education, physio-therapy, the training and education of the blind, the training and education of the disabled soldier who suffers from deafness or from speach defects, and after the armistice a subsection on convalescent centers. A director was appointed and made responsible for the activities of each subsection.

In the application of curative work in the wards for bed and chair patients, women were secured as civilian employees, designated as Reconstruction Aides in Occupational Therapy. Only those women were accepted for this service who were fundamentally qualified because of previous education or experience as teachers in high schools, colleges and universities, and who were willing to take short courses of intensive training in the arts and crafts. Some of the aides were accepted because of their experience in civil life as medical social welfare workers.

Civilian employees who were accepted in this service were fundamentally qualified, because of intensive training in schools and hospitals, to give massage, local baths, thermo-therapy, and other forms of physical treatment.

Recreation in the form of exercise in gymnasia and in outdoor games was secured through the American Red Cross, co-operating with the Y. M. C. A., the Knights of Columbus, the Jewish Welfare Board and in the convalescent centers with the commission on training camp activities of the War Department.

Facilities for the application of curative work, physio-therapy, and recreation in each of the military hospitals functioning in physical reconstruction was secured by the construction of new buildings, or by the alteration of existing buildings, and gardens and lands were secured by purchase or lease for the training of men in outdoor pursuits for playground purposes.

The equipment for work shops and for physio-therapy was secured as rapidly as the conditions due to the governmental war program permitted. The American Library Association co-operated in furnishing desirable text books and light and heavy literature for the use of the disabled men. The division of physical reconstruction, co-operating with the Federal Board of Vocational Education, prepared courses of study embracing fifty different educational subjects and trades as guides for the disabled soldiers and for the teachers in the application of the curative work shop schedule. The application of occupational therapy and of physio-therapy in the treatment of sick and wounded disabled soldiers has proved of the greatest value in the earlier and more certain cure of patients.

At the U. S. General Hospital No. 11, Cape May, an efficient school for the disabled soldiers with deafness and defects of speech successfully teaches lip reading and correction of speech defects. The patients receive prevocational or vocational training.

At General Hospital No. 7, Roland Park, Baltimore, there was established a school for blind or near blind soldiers, sailors and marines. The blinded man is taught how to dress, feed himself and get about as an independent individual, and at the same time instruction is given in Braille, typewriting and coincident training in occupations suitable for the blind.

The disabled tuberculous soldiers are treated in military sanitaria. Curative work has been established in each one of these institutions. Curative work for the tuberculous soldier is modified to meet the varying clinical conditions of that disease and is applied under constant watchful medical supervision. Curative work has proved of the greatest value to the tuberculosis patient in the prevention of hospitalization, and is especially valuable in the treatment of the convalescent in the production of the final hardening process which is so valuable in the prevention of relapse when the stage of inactivity of the disease has been secured.

After active warfare ceased, disabled soldiers from the A. E. F. were returned to the United States in large numbers. It became necessary to amplify the number of hospitals with facilities for physical reconstruction in this country.

The problem of supplying the necessary personnel, available room for shops, adequate school rooms, space for physio-therapy, gymnasia and required equipment was satisfactorily met.

Following the cessation of hostilities and the more rapid return of disabled soldiers from the A. E. F. to the United States, convalescent centers were established by the General Staff in nineteen of the training camps. To these centers were sent convalescent detachments from overseas and convalescents from general and base hospitals on a duty status. The final hardening process before discharge of the soldiers in the convalescent centers was brought about by the application of curative work, military drill, setting up exercises, and recreational play.—*Leo C. Donnelly, Detroit.*

On Focal Infection as a Cause of Painful Heel. By Sigmund Epstein, M. D., New York. *Medical Record*, Vol. 96, No. 5, Whole No. 2543, New, York, August 2, 1919.

The tonsil is a clearing station for mouth infections, and it is manifest that the tonsillar attacks are often due to dental troubles; hence some arthritides are not cured until appropriate extraction is carried out, or until pyorrheal pockets are cleared up.

The dental cases can be exceedingly acute and destructive. The more chronic cases are seen in middle age or elderly patients, and osseous changes can be demonstrated around the joints. Total ankylosis is not common.

I will offer a few impressions of my study of many cases seen in private and clinical practice:

1. I believe that the results of extraction of teeth are more brilliant than those of root-amputation.

2. Offer the beneficial results of removal of septic bridges, and of forgotten or buried septic roots can be felt within a day, after the eradication.

3. Do not expect this to happen where there are marked bony changes around the margins of the joints, such as the X-ray shows in the form of osteophytes of greater or lesser size.

4. The results of extraction of septic dental foci are more favorable in younger patients, especially where the symptoms are polyarticular or muscular.

5. Physicians should be able to recognize pyorrhea, neglected or infected teeth, teeth of dark appearance, gold and porcelain crowns. Sinuses, especially small ones, should excite suspicion and should be followed up roentgenographically. In this day and age of literature on focal infections and their diligent tracing, it is to be wondered that cases still escape the vigilance of the most careful medical attendants. Especially when the patient is a practicing physician is the loss of time as well as the extension of the disease process more lamentable.

Arthritides and osteoarthritides are common from dental infection, but distinct calcaneal periostitis has not been, in my observation, so common.—*Leo C. Donnelly, Detroit.*

Bone Regeneration and the Conditions of Success in Bone Graft. Dupuy De Frenelle. *Press Medicale*, June 23, 1919.

Bony spiculae at the ends of the fragments of fracture diaphyses, being denuded of the periosteum by the traumatism, die off, even if recovered by periosteum. Osteoblasts travel from the fragmental ends and the penetration takes place from all layers of the bone. Of these, however, the medullary canal is of the greatest importance.

The bony bridges uniting the fragments show a tendency to disappear in the measure in which new bone formation from the osteoblasts takes place. Three factors are to be considered in the preparation of the fragments: The opening of the medullary canal, the refreshing of the ends and the preparation of the graft beds.

The graft should be cut of spongious and persistant bone tissue. It shonld be proportionate in length and thickness to its requirements. The larger its medullary surface, the better its bone production. In regard to regeneration it does not make any differenee, whether or not it is covered with periosteum. Exact alinement of the graft and the bone ends is indispensable.—A. *Steindler, Iowa City, Ia.*

Treatment of Joint, Bone, Nerve and Muscle Injuries by Mechanical Means. By Joseph C. Scal, M. D., New York. *New York Medical Journal*, Vol. CX, Whole No. 2122, No. 5.

In sprains the sooner mechanical treatment is instituted the more rapidly a normal condition can be obtained. After resting the injured part and applying cold applications for 24 hours, active and passive treatment, consisting of a exercise and massage, should be begun. No pain accompanies proper movement; the presence of pain is an indication motion should be stopped temporarily. This treatment can do no harm as there is no danger in exercising and using a sprained limb, in fact it tends to restore function to muscles and joints, reduce swelling and edema, promote absorption, and prevent adhesions, no matter how slight the injury may have been.

In cases where the relief of swelling is necessary during the first 24 hours a bandage applied firmly and evenly over a number of layers of absorbent cotton will obtain the desired result by preventing further extravasation and promoting absorption in from 6 to 8 hours. This treatment should be used only in the first 24 hours after the injury. In cases where the confidence of the patient cannot be obtained so as to make him co-operate in exercising and using his limb, strapping is the next best thing.

Fractures—The ideal treatment of fractures consists of reduction and the X-ray; prevention of recurrence by splintage; relief of pain and elimination of edema by early baking and gentle massage, and the prevention of adhesions and muscular wastings by graduated contractions. Early bakings, light massage and passive movements will shorten the period of disability and length of treatment and prevent after effects, provided good union and good apposition exist; will prevent adhesions and stiffness in joints; reduce atrophy of muscles to a minimum and prevent excessive callus. When a fracture is near a joint and

kept immobilized in splints until union is firm, the joint will become stiff and muscular atrophy will result. In these cases it is advisable to remove the splints as early as possible and institute baking, massage, and the various mechanical movements.

Nerve injuries.—Especially in peripheral nerve injuries weakness and muscular wasting inevitably result and these are followed by paralysis and contractures. When nerves are cut the joints should be kept free and the nutrition of the muscles around them maintained so that the joint will be able to functionate when the nerve recovers. If a severed nerve is sutured, which should always be done if possible, it must be held in a position which will produce as little tension as possible on the nerve or paralysed muscle until function is restored.

Treatment by heat.—An affected limb should be kept warm and protected from cold. Heat also makes treatment by massage and electricity more effective and should be applied before and after such treatment when possible.

Treatment by massage.—To be effective massage must be gentle at the beginning, all movements must be painless and should be applied daily from the early stage.

Treatment by exercise.—This is used for re-educating and redeveloping wasted muscles and consists of active exercise against resistance. For a shoulder joint with limited movement the so-called "wall climbing" exercise is advised. This consists in the patient standing with his face against a wall or door, and putting the hand to the affected side as far up as he can, endeavoring to place the finger tips on the top. When he reaches the top he fixes the hand with the other well hand and bending knees slightly uses his body weight to exert a pull on the joint.

Treatment by graduated contractions.—This is ideal routine for muscular wasting and muscular insufficiency, and no matter how wasted a muscle is, provided the nerve supply is undisturbed, a contraction can be obtained. It should be given daily from 10 to 15 minutes together with gentle massage. It is indicated principally in sprained muscles. The method of application is to place the limb at absolute rest, and apply the faradic current, the degree of contraction being controlled by the manipulator, and a group of muscles is stimulated while in absolute relaxation.

In conclusion I would say that a stiff and crippled part can be restored to functional utility only by getting rid of adhesions, resorting mobility and rebuilding the muscular tissue which has been permitted to waste and atrophy. With the early application of the forms of treatment outlined here we will see fewer stiff joints and wasted members than we have seen in the past.—*Leo C. Donnelly, Detroit.*

Bone Regeneration Following Osteomyelitis. By Stewart L. McCurdy, M. D., F. A. C. S., Pittsburg. *The Pennsylvania Medical Journal*, Vol. XXII, February, 1919.

This article is well illustrated and does not entirely follow the "beaten path." He states that the technic of the removal of a sequestrum and rearranging of the involucrum is very important. It consists in chiseling away

sufficient of the involucrum where it is thinnest to remove the sequestrum, and then breaking down the involucrum in such a way as to push it down into the cavity left by the removal of the sequestrum, completely filling the space. The new bone fragments act as bone clips do elsewhere. Such a wound should be poured full of 3% tincture of iodin after removing the sequestrum and before breaking down the involucrum. The bone, if possible should be reduced in size so as to permit the closure of the skin throughout. No packing should be used; it destroys blood clot organization and prevents repair. No wound is going to close until it is ready, and packing may prevent closure.

The method of repair is about as follows: The blood clot which fills in the cavity serves as a trellis work into which the leucocytes begin to pour from the healthy blood vessels immediately after all operations and injuries. In the course of a few days, the blood clot has been entirely displaced by the scavenger leucocytes and teh cells thrown out along the margin of the wound for the purpose of reconstruction and repair. The reparative cells eventually take the place of the leucocytes and become thoroughly organized, and the cavities are thus filled with new formation.

The author's conclusions are:

1. Bone regeneration is from the osteoblasts only and cannot come from the periosteum or other tissue.

2. Sequestrum, though very loose, should never be removed until regeneration of new bone has advanced far enough to maintain the normal position and perform the normal function of destroyed bone.

3. Three and one half percent. tincture of iodin is the antiseptic par excellence in all cases of bone infection. It should only be used once a week.

4. Packing in and around bones that are dead, destroying the healthy granulations, also destroying the bone's normal function of producing new bone throughout its circumference, should not be used. I am not sure who introduced this pernicious practice, but I believe it has done more harm to bone surgery than any other one thing that has happened in centuries.

5. The serum of repair is not pus, since it is not phagocytosis and does not require strong wet dressings, as practiced by so many surgeons as a routine. Normal salt is to be preferred when the patient is without temperature.—*Leo C. Donnelly, Detroit.*

Transplantation of Bone for Defects of the Head and Neck of the Femur. By Chas. Davison, A. M., M. D., F. A. C. S. *Surg., Gy., and Obstet.*, Vol XXIX, August, 1919, No. 2.

In a very well illustrated article the author states that autoplastic transplantation of bone is of value in three types of defects of the head and neck of the femur, but in all cases the patient must be vigorous enough to withstand the operation, and young enough as an economic possibility, to warrant the attending discomforts and dangers of the procedure and the expense of time and effort required for a successful issue.

1. Recent fractures of the neck of the femur without impaction may be repaired by grafting a segement of fibula across the line of fracture. To

obtain ideal results the repair should be performed early before the vitality of the capital fragment has been disturbed by lessening of its blood supply. Under favorable conditions the union of the fracture resembles healing of wounds by primary intention and without doubt the capital fragment retains its integrity and persists as a vital portion of the femur.

2. Ununited fracture of the neck of the femur with diminished vitality of the capital fragments may be repaired by transplanting a segment of fibula across the nonunion. Under favorable conditions the transplant grafts to the lower fragment in a manner similar to that in recent fractures. In the capital fragment the process is different. It simulates the healing of wounds by granulation. There is a stimulation of osteogenesis by the transplant with projection of new bone cells into the devitalized fragment which acts only as frame-work for the deposition of new bone. The old bone is gradually absorbed as it is replaced by new bone. Under the stimulus of the transplant, new bone is deposited in and around the area of the nonunion, until the old fracture is obliterated. Later both the transplant and the new bone are absorbed and modified until there is compensation between elasticity, strength and function.

3. The head of the femur, destroyed by injury or disease, may be replaced and fair function re-established by transplantation of the head and upper part of the fibula into the upper end of the shaft of the femur in such a manner that the articular surface of the head of the fibula will articulate with the acetabulum. Under favorable conditions the transplant will graft to the shaft of the femur. The part of the transplant which replaces the head and neck of the femur, will hypertrophy until its size and strength are sufficient to meet the functional demands made upon the hip-joint in walking.—*Leo C. Donnelly, Detroit.*

The Work of the Federal Board for Vocational Education. By Mr. H. L. Brunson, Superintendent of Placement, Division of Rehabilitation, Federal Board for Vocational Education, Washington, D. C. *Pennsylvania Medical Journal,* Vol. XXII, May, 1919.

The first step in this program of rehabilitation is to get in touch with the disabled man. The plan is to get in touch with him at the hospital, just as soon as possible in view of his physical condition, and advise with him concerning his future; to find out what his experience has been, what education he has received and guide him into an occupation in which the equipment which has been spared to him can best be used. Choosing the occupation is a big task, as the patient usually has a very definite idea about what he should do, and in many cases it is difficult to convince him that his judgment is wrong. In most cases it is necessary to place the man in some position and try him out on the job to determine whether he can carry on in that line of work. Development will prove whether he can or not. If unable to make good, then he is a subject for training. Reference is made to this point to show the character of the problem confronting the federal board.

It is planned by the federal board to provide trainlng for these men in every occupation known to be suitable. This phase of the work cannot be carried on

to any great extent in schools. It will be carried on in factories, mills, shops and offices, and everywhere that men can be trained, or tried out in employment to prove whether they can, with their remaining equipment, do the things that they must be able to do in order to carry on the job. This requires the assistance of the employer, and the sympathy of fellow workmen. In fact the aid of every factor in society is needed to carry out the work successfully.

After a man has been trained, or placed in employment as a test of whether he can carry on in that particular line, he is to be followed up. He will be interviewed frequently. His employer or the person directing his training will be required to provide the federal board with information at intervals, so the board may know how the man is getting on. If he requires shifting or direction in some other line, the officer of the board will know of it and will change his training or secure for him other employment.—*Leo C. Donnelly, Detroit.*...

Returning the Disabled to Economic Independence. By Mr. Douglas M. McMurtie, Director, Red Cross Institute for Crippled and Disabled Men President, Federation of Associations for Cripples, New York. *The Pennsylvania Medical Journal*, Vol. XXII, May, 1919.

In one way compensation legislation has failed to meet the needs of the disabled. In the light of our present knowledge and experience, compensation practice, taken alone, has fallen short of success. The legislation has not been, in its results, in any way constructive. It extends to the man a meagre stipend on which he may or may not be able to live, and leaves him to exist in idleness. Present provisions of law are almost an incentive to idleness in that a man's compensation award is prejudiced the moment his economic condition begins to improve.

We have had enough experience with the disabled soldier to realize that the only plan worth while is to restore him to economic independence, to place him beyond need of monetary aid or compensation and pension laws,—and thus solve his problem permanently and satisfactorily.

It is not a measure of philanthropy, but one of clear, cold, business judgment. For industrial rehabilitation, no one needs to pay the cost. There are a great many ways by which insurance companies and state funds can save themselves money. One is by provision of unlimited and high grade medical attention.

The chief expense of training men is not putting them into classes and having them taught; it is maintaining them while in training. No matter how excellent your mechanism of re-education may be, if you go to a man earning $6.00 a week and say, "This is too low; you could be earning at least $20.00 weekly; come to our school and we will train you for a job," it is out of the question for him to undertake training because, in the meantime, his family would starve. So we face the necessity of maintainance. During compensation a man would have some income on which to live but after that period has expired maintainance becomes a serious problem, and we have to supply money to support the man while undergoing training.

A plan of paying a minimum award for personal inconvenience involved as result of a given disability, not to be reduced under any circumstances is worthy of serious consideration. There would then be further compensatory advantage in the provision of thorough re-education, and in case a man made an earnest attempt at rehabilitation and failed, there would be further award in the discretion of the state compensation authority making the total benefit at least as great as, and preferably greater than the disability payments under present practice.

There is considerable discussion of the extra accident hazard in the case of men already disabled. There may be such added hazard in the employment of disabled persons placed at random, but I believe that such men when wisely placed involve no greater risk than the able-bodied. A man who has once been injured will take some care not to have a second accident.

The other influence with which we have to deal is the general attitude of the employer toward disability. He has always regarded the disabled man as a hopeless case and is not willing to believe that such a man can do anything useful. The first necessity in operating an employment bureau for disabled people is to get at the employer and convice him that men who are disqualified for some jobs are not shut out from others, and make him willing to take the cripple into service. One of the most useful mechanisms to bring employers to recognize the possibilities of crippled workers is known as the "industrial survey to discover openings in industry for the physically handicapped."—*Leo C. Donnelly, Detroit.*

THREE AMPUTATIONS OF THE FOOT DESIGNED TO RETAIN THE CALCANEAL TREAD. By C. E. Corlette, M. D., Ch. M. (Syd), D. P. H. (Camb), Sydney, Australia. Surgeon, Sydney Hospital, New South Wales. *Surg. Gyn. and Obstetrics*, Vol. XXIX, August, 1919, No. 2.

In a well illustrated 20-page article the author describes three new amputations of the foot at the mid tarsal joint. The technic should be closely followed as his work has been amply proven with work on the cadaver.

This article contains a volume of carefully worked out details which makes it difficult to abstract. The original article is well worth studying.

1. Flaps. Preserve all viable material, or at least an ample surplus, and trim down later. The upper flap is cut by an incision starting at a point midway between the tip of the lateral malleolus and the tuberosity of the fifth metatarsal bone and coming across the dorsum of the foot to a point a little behind the prominence of the navicular bone on the medial side of the foot. As the cut crosses the dorsum of the foot it curves forward somewhat, crossing the bases of metatarsal bones. The plantar flap extends a little farther forward on the sole than the upper flap does on the dorsum. But it is better to have some surplus to cut down than too little to work with.

2. Disarticulate at the mediotarsal joint.

3. With the osteotome remove the lower third of head of talus, shave the plane surface underneath the remainder so as to give the plane a certain

amount of slant upwards as the cut runs backwards. The interosseous ligament presents itself.

4. With the osteotome cut through the base of the sustentaculum tali flush with the side of the calcaneus, sever its ligamentous attachments and remove it.

5. With the osteotome cut the greater process of the calcaneus at cuboid articulation horizontally across, pointing upward and backward to the groove just in front of the convex articular facet on the upper part of the calcaneus

6. Loosen the calcaneus from all soft parts except on the plantar surface and its edges.

7. Finish paring, by thin shaving, the under surface of the talus, until the whole under aspect of bone presents a flat surface with an upward backward slant.

8. With an osteotome shave off superior surface of calcaneus upward and backward to a point on the saddle-shaped superior surface behind the posterior limit on the convex articular facet.

9. Push the calcaneus well forward placing cut surfaces of both bones in close opposition.

10. Bore a hole horizontally from side to side through the neck of the talus, behind the head and fairly high up. Bore a similar hole through calcaneus a little behind hole in talus.

11. Cut and trim the flaps to the exact shape and size desired. In doing this leave the anterior tendons long, so that they can be sutured to the base of the lower flap.

12. Remove the tourniquet and attend to haemostasis, using plenty of hot water.

13. Pass wire or kangaroo tendon through holes and tie bones together.

14. Appropriately trim down projecting portions of calcaneus.

15. Suture the anterior tendons to the lower flap in front of the calcaneus, as low down as possible.

16. Close the wound, putting a short and sufficiently wide tube at each side to provide for oozing. These tubes should be removed within 36 hours.

Operation 3.

1. Flaps similar but shorter than No. 1, disarticulate at mediotarsal joint.

2. Cut off sustentaculum as in No. 1.

3. Enucleate talus.

4. With osteotome remove a slice of the distal extremity of the tibia and lateral malleolus at same level as that prescribed for Syme's operation.

5. With osteotome section calaneus beginning at base of convex articular facet, slope upward and backward to apex of smooth surface above insertion of tendo achilles. The surplus lengths of all tendons should be removed well back.

6. Push calcaneal remnant well forward 2½ or 3 cm. ahead of tibia, bringing natural tread in line of pressure.

7. Bore transverse holes through tibia and calcaneus and wire them together.

OPERATION 2.

1, 2, and 3. Incisions, flap material, removal of sustentaculum and talus same as in No. 3.

4. Soft parts separated from either side of calcaneus. Clean lower anterior extremity of tibia and surface and borders of malleoli.

5. Remove prominent upper and anterior part of greater process of calcaneus.

6. Shave upper surface of calcaneus until a broad surface with an upward and backward slant is formed. Excellent results can be obtained without going back to posterior surface. In under surface of tibia cut a trench, sparing malleoli, from before backward to receive calcaneus.

8. Trim fibular malleolus to allow fit.

9. Drill holes through malleoli.

10. Drill transverse hole through calcaneus.

11. Remove tourniquet, wire calcaneus into place.

12. Smooth off anterior surface of calcaneus.

13. Close wound.—*Leo C. Donnelly, Detroit.*

THE CRIPPLES OF A COMMUNITY. A SURVEY OF THE DISABLED CHILDREN AND ADULTS IN CLEVELAND, OHIO, AND A STUDY OF THEIR NEEDS. By Douglas C. McMurtrie, New York. Director, Red Cross Institute for Crippled and Disabled Men; President, Federation of Associations for Cripples. *Medical Record*, August 23, 1919.

How many cripples are there in any given community? To what extent have they made their own readjustments and placed themselves beyond the necessity of assistance? What are the needs of others who have encountered difficulties, educational or economic? An attempt to answer these questions for the city of Cleveland, Ohio, was made in a survey conducted during 1916 by the Welfare Federation of Cleveland. The findings of the study have just been made public.

The "Cleveland Cripple Survey," as it is known, had its genesis in the interest of public spirited citizens of that community in the cause of the crippled child, and the desire to have reliable and scientific guidance in the effort to make further provision for cases of juvenile disability. The survey is more than a census, for each case was studied to ascertain what light it could throw on the needs of the cripple in general. It was found that the cripples themselves might be considered the real authorities on the problem of physical handicap. As the report says, "A man with double club hands and double club feet, a meagre education and no medical treatment in his life, but who supports himself and others for nineteen years without aid, can, if he be a thoughtful person, speak with authority of handicaps.

The definition on which the survey work was based is set forth in the statement of purpose made by the committee: "To discover the economic and educational needs, capacities and possibilities of children and adults in Cleveland who are handicapped because they lack the normal use of the skeleton or skeletal muscles."

There were found in Cleveland 4,186 cripples of all ages, which calculated in ratio to total population indicates six cripples to every thousand inhabitants. The age distribution showed 22 per cent. under 15 years of age, 61 per cent between the ages of 15 and 60, and 17 per cent. 60 years old and over.

In sex distribution 63 per cent. were male and 37 per cent. female. The discrepancy is due to the greater liability of males to accidents. Within the working age limits there was even more marked disproportion. Among those between 15 and 60 there were 68 per cent. male and 32 per cent. female. Classified as to color there were 97 per cent. white against 3 per cent. colored. Of the 4,076 white cripples 66 per cent. were native born and 34 per cent. foreign born.

One of the first requirements in determination of the needs of cripples is a knowledge of the age periods in which crippling most frequently occurs. That the problem is largely one of the childhood period is shown conclusively. The community is justified in concentrating on the surgical treatment and the provision of special educational advantages for crippled children. It is an almost startling fact that 49 per cent. of the total cases covered by the survey became cripples before the age of 15, while 34 per cent. developed their handicap before the age of 5.

The next finding of interest showed that 59 per cent. of the cripples over 15 years of age were employed.

The authors suggest that the work for crippled children should be met as part of a general, liberal program for prevocational education.

The problem of the crippled adult is a problem of working life. Legislation should be passed adjusting for employer and employee alike all matters of compensation and insurance that now stand in the way of re-employment.

The knowledge gained during the war along the lines of surgery, prosthesis, occupational therapy and vocational education should be widely spread and applied to all cripples, whenever possible.

Provision for industrial training for the competent among the handicapped should form a part of an adequate vocational training for all citizens, under federal or state auspices.

There should be special provision for placement of those who cannot place themselves and for the special employment in home industry of semi-invalid cripples taking some small part in active life.

Propaganda should overcome the prejudice of the public against cripples. "An ambitious mechanic, looking for a real job, finds himself classified with the shoe-string peddler, just because he has the same disability. A man with crutches hears people 'speaking up loud' to him, exactly as they would to a person with smoked glasses or to foreigners whose language they do not understand. These apparently trivial things are in reality signs of general inability to see the man behind the handicap, and are the very things that make

the cripple think he is helpless. They contribute to idleness among cripples and help create the group of sensitive recluses who only wish to come out after dark and to discourage the workman who keeps his crippled hand well hidden in his pocket."

Most important of all, methods of prevention should be devised, in regard to the accidents of industry, to those of everyday life, and to the ravages of such diseases as infantile paralysis and the tuberculosis of early life. Scientific study along such lines can and must reduce greatly the proportion of accidents in future years.—*Leo. C. Donnelly, Detroit.*

Congenital Radio-Ulnar Synostosis. By James Warren Sever, M. D., Boston, From the Orthopaedic Department, Children's Hospital. *Surg., Gyn. and Obstet.*, Vol. XXIX, August, 1919, No. 2.

The condition is apparently an hereditary one, prone to occur in succeeding generations without any known cause from an embryological point of view. Feidt, quoting Lewis, states that "at the sixth week of foetal life the distal ends of the forearm bones were distinct and separated from each other, and that the perichondrium of the proximal end of the radius was continuous with that of the adjoining surface of the ulna." Lambertz' law relating to these cases is as follows:

"In the extremities, the ends which show a more elaborate development as regards shape have a less degree of growth, hence, as the radius does not develop in form it seems to increase in length." This embryological condition may therefore be carried over into full foetal development in some cases, especially those with an atavistic tendency."

Clinically the cases present a bony fusion of the upper ends of the radius and ulna not involving the elbow joint and resulting in a lack of ability to supinate. There is some ability to turn the palm of the hand up but only by means of outwardly rotating the humerus. No power of true supination exists. The bony fusion may cover an area 3.5 to 6 centimeters; in the case reported the distance was 3.5 centimeters. The radius is generally bowed as well as thickened.

Operation consists of a 1½ inch incision on the outer side of the forearm about 2 inches below the elbow-joint. One-half inch of the radius is resected. No attempt is made to divide the interosseous membrane or head of the radius. The hand and arm are put up in plaster in the position of full supination and held for six weeks.

The simplicity of this operation as contrasted with the more difficult procedures which involve the section of the head of the radius with the attempt to establish a new joint and which have led to poor results, is in its favor.

The child has a very rigid course of after treatment in muscle training, exercise and massage, all leading to the development of the forearm muscles, especially the supinators which are markedly atrophied from disuse.—*Leo C. Donnelly, Detroit.*

PROGRESS OF ORTHOPAEDIC SURGERY. By C. Hermann Bucholz, M. D., Robert Soutter, M. D., Lt.-Col. Robert B. Osgood, H. C. Low, M. D., Maj. Murray S. Danforth, Boston. BONE AND JOINT SURGERY. *Boston Medical and Surgical Journal*, Vol. CLXXXXI, No. 7.

ARTHROPLASTY.

Baer has had the chance to reopen four of the joints where arthroplasty with animal membrane had been done. In each case he found that the joint space persisted and the lining of the bones was perfectly smooth. The microscopic examination showed that the membrane is transformed into a fibrous tissue which covers the bone and that a joint-like space is formed with fibrous walls, similar to the walls of a cavity encysting a foreign body.

The advantages of the membrane are: (1) the joint will retain as near its normal shape and size as possible; (2) the simplicity of the operation; (3) the stability of the joint; (4) less chance of infection because of the lessened handling; (5) less painful after-treatment, because movements are not begun before three weeks; (6) a normal joint is the ultimate result; no foreign substance is left because the membrane is absorbed within 60 to 100 days.

The membrane must be (1) thin and flexible; (2) tenacious to withstand disintegration for 60 to 100 days; (3) durable; (4) absolutely sterile. The membrane is made in the following way: The pig's bladders, carefully selected, are thoroughly cleansed and disinfected and the submucosa obtained. They are then soaked in a medium hard potassium chromate solution for 24 hours, after which they are cut into the proper size, stretched on boards and exposed to the sunlight for 3 days, until the color corresponds to the reduction of the chromic salt. After being freed from all their soluble chromic salts they are thoroughly dried, and are then inserted into sterile glass tubes containing chloroform. At the time of the operation these tubes are boiled for 5 minutes. The tube is then broken and the membrane, placed in normal salt solution for 10 minutes before using.

Allison and Brooks have made a careful and comprehensive study of the history of arthoplasty and have contributed to our knowledge by valuable experiments. They agree with Baer in considering animal membrane the most promising material for interposition, but emphasize that the substance used must have the least possible irritating properties. They have prepared a silver impregnated fascia in the following way: Living fascia is immersed in a solution of silver nitrate until it is hardened, and then the silver nitrate absorbed by the fasca is reduced to metallic silver. This gives a sterile, pliable, thin, non-irritating membrane. The reasons for the addition of the silver are: (1) metallic silver has definite inhibitory powers both for organisms and tissues; the method of fixation is such that the membrane is always perfectly sterile; (3) the fixative, which is of necessity an irritating chemical, is entirely destroyed. The fascia may be taken from the patient by a preliminary operation. In doing arthoplasty on the knee joint the authors have previously used the horseshoe incision with temporary resection of the tibial tubercle; but recently they have given up this method of approach in favor of the anterior longitudinal incision, because they emphasize the necessity of early active and passive mo-

tion, which would not be safe before the time the tibial tubercle is perfectly united.

Bone Grafts.

Keith discusses the history of bone grafting and sums up the subject as follows:

Among the conditions which determine the successful grafting of bones or bone fragments, we must place first asepsis. Grafts answer best which are taken from the patient's own body; the closer the genetic relationship of the graft-host, the better is the graft likely to answer. The graft-host should be young, and those grafts do best which contain all three elements of bone—bone, periosteum, and medullary tissues. The graft-bed must be free from blood-clot. Washing in normal saline solution damages the vitality of a graft. A graft must be placed so that the contact is effected by adjacent fragments; the contact must be firm and so designed that the graft becomes early subject to the mechanical stresses and strains of the part.

Numerous experiments as well as a sufficient amount of clinical experience have convinced Gallie that boiled bone is an excellent substitute for the autogenous graft. The great advantage lies in the chance to model the graft beforehand and save time during the operation. In this way plates and screws have been made for fractures, long screws for fractures of the neck of the femur, grafts especially modelled for spinal operations, etc. Gallie points out the difference which exists between bone grafting in fractures and in Pott's disease in so far as in the femur the contact is uninterrupted and in the latter not. But by examining operated cases 7 months and 2 years after the first operation, he has found that even those parts of the graft which have not been in contact with bone become organized and at the end represented living bone. The observation that cancellous bone will be vascularized and permeated by living osteoblasts much more quickly than the dense bone of the cortex holds true also for boiled bone. Hence for plastic operations the material should be as porous as the required strength will allow. Beef ribs are excellent for spinal grafts.

Having found great difficulties in bridging defects in one bone of the forearm by Lane plates or intramedullary grafts, Bancroft has used small bone fragments after experimenting on dogs in the following way: A piece of 3 cm. length is removed from the radius and the periosteum excised over the defect as well as 1 to 2 cm. over both ends. The excised bone is split lengthwise and all the endosteum removed. Then it is cut in small fragments of 1 to 2 millimeter width and these are inserted into the defect. Good union was thus obtained in 22 cases. Bancroft thinks that too much importance has been placed upon the origin of the bone cell as the vital factor in bone repair. Bone is mesoblastic in origin; in its repair calcium salts are deposited on the intracellular elements of connective tissue, forming new bone. The connective tissue cell by metaplasia becomes a bone cell. Periosteum is connective tissue, hence prone to form bone, but it is not the only connective tissue that has this function.

New Approach to the Hip Joint.

Smith-Peterson describes a new supra-articular subperiosteal approach to the hip joint as follows: An anterior incision is made from the anterior superior spine along the anterior border of the tensor fasciae latae to below the level of the trochanter. Then a curved incision is made from the anterior superior spine along the crest of the ilium, through the origin of the gluteus medius about one-half inch below the superior border of its periosteal attachment. When the skin muscle flap is freed from the ilium by subperiosteal dissection and the tensor fascia is reflected together with the flap the capsule is exposed and is entered above the ilio-femoral ligament.

The operation has so far been used in cases of congenital dislocation, for which it gives an excellent approach: but the author believes that also for other procedures, such as arthrodesis, his method is likewise of advantage.

Congenital Elevation of the Scapula.

Peckham has devised a new method for the relief of congenital elevation of the scapula. From a vertical incision between the scapula and the spinous processes, a wedge shaped piece of the trapezius is excised with base at the spine of the scapula. The lower angle of the scapula is drawn toward the spine and fastened with chromic catgut to the region of the tenth, eleventh and twelfth spinous processes. The result in the reported case has been very satisfactory; the shoulders are almost level and almost full elevation of the arm is possible.

Brooke's experience shows that a considerable damage may be done to the tibia by the removal of a piece of bone for a plastic operation. He has seen a fracture of the tibia in three cases where a grafting had been done for fractures of the upper extremity. The patients were allowed to walk after five weeks and the fracture of the tibia occurred from a very slight injury. In all three cases the removal of the graft had been done with a motor saw and without chiseling. Hence it would seem well in such cases to protect the tibia for a longer time, when weight bearing is allowed so soon after the operation.

Treatment of the fractured femoral neck has been the subject of frequent consideration and most observers recommend Whitman's abduction treatment as the method of choice at least for the early cases, both in adults and children, while they want to have the operative method reserved for certain fresh cases and for the old, ununited cases. The most remarkable contributions along this line are those of Albee and Brackett. Albee has perfected the bone grafting method which he calls glass stopper method. His technic is as follows: The fragments are properly adjusted from an anterior incision. Then from a lateral incision a canal is drilled through the subtrochanteric region, the neck and the head. In this canal is inserted a peg made of the tibia which fits exactly in the hole, like a glass stopper in the bottle.

Brackett has obtained very encouraging results in old ununited fractures by grafting the femoral head from the trochanteric region in the following manner: From a large flap incision the trochanter is exposed. The insertions of the gluteus medius and minimus are lifted up with a thin slice of bone and

the joint is opened. Then the trochanteric region of the femur is shaped to fit into a round depression which is made in the head. In abducting the femur one can now see the head move upon and with the shaft, usually to a surprisingly great extent. The leg is held in full abduction until the plaster cast is applied. No other fixation of the fragment is attempted than by exact suture of the capsule and the position of the leg in abduction. The glutei are fixed in place and the soft tissues sewed in layers.

Fat Embolism.

Caldwell and Huber report on an experimental study of the production and prevention of fat embolism due to trauma to bones. They found that crushing the tibias of mature rabbits produced a moderate and fairly constant amount of fat embolism as determined by counting the fat droplets in a large number of representative microscopic fields, in stained sections of lung tissue. Esmarch constrictors placed on the legs of rabbits, previous to the crushing of the tibias and removed after two hours, lessen distinctly the amount of fat entering the lungs during the remainder of the experimental period; this effect is much less marked and more uncertain when they are removed at the end of a half hour or even one hour. The amount of fat embolism which develops after the removal of the constrictors is dependent largely on the activity of the animals. Rabbits kept in chloral hydrate narcosis during the entire experimental period, following the crushing of the tibias, develop only a small amount of fat embolism although the constrictors are not used. The removal, by means of motor saw, of grafts from the tibia of normal dogs and rabbits produces an appreciable but very removal of the tibial grafts from dogs increases very slightly the amount of fat entering the circulation. The spinal part of the Albee bone transplantation operation, on normal rabbits, produces more fat embolism than does the tibial part.—*Leo C. Donnelly.*

A Clinical Study of Nerve Anastomosis. By Alfred W. Adson. *Annals of Surgery*, Vol. LXX, No. 2, August, 1919.

The author reports a study of forty-one cases of nerve anastomosis from the Mayo Clinic. A short review of the literature is given first. The report includes nine facial, seven ulnar, one radial, seven median, ten musculo-spiral, four external popliteal, two sciatic and one recurrent laryngeal. The suture material used was either fine silk or fine chromic catgut. 85.5% had end to end anastomosis; 19.5% had plastic flap operations. In 49% fascial covering of the anastomosis was used; vein covering was used in 10%.

The results were: 73% improved; 17% failures; 10% not determined.

The author summarizes: The regeneration of the peripheral nerves may be accomplished by nerve anastomosis. The degree of regeneration depends upon the duration of time between injury and repair, the actual loss of nerve tissue and the retraction of the nerve ends. In the technic of nerve repair no covering is necessary if the freshened ends can be sutured in close apposition; if an intervening gap remains it should be tubulized, preferably by fascia; if the gap is longer than five cm. tendon transplantation and arthrodesis should be con-

sidered instead of nerve anastomosis; autogenous transplants may be considered for short gaps, but they are of no greater value than tubulization.—*Murray S. Danforth.*

Surgical Treatment of Scars Resulting From War Wounds. Walther. *Bulletin de L'Academie de Medicine.*

The author's subject is that of systematic removal of extensive scars, so often the cause of permanent disability in war wounds. The author maintains the view point that these scars should be dissected en masse, including the cutaneous scar. When dissecting the scar one must not neglect to prepare the skin backward very far until normal subcutaneous cellular tissue can be exposed. There is also the scar infiltration of the neighboring muscles to be considered. The entire fibrotic mass should be excised and wound prepared by end to end suture. Where the scar is very extensive the repair might be carried out in several stages. The author also recommends bathing of the tissue in normal saline solution during the operation, which also has a most useful hemostatic action.

No mention is made of a most important point; that is, the substitution of the defect created by the thorough resection and excision of the scar.—*Arthur Steindler, M. D.*

Vol. I, No. 11 NOVEMBER, 1919 Old Series: Vol. xvii, No. 11

The Journal of Orthopædic Surgery

DISABILITY FOLLOWING INJURIES TO THE BACK IN INDUSTRIAL ACCIDENTS

BY JAMES WARREN SEVER, M. D., OF BOSTON, MASS.

Presented at the Annual Meeting of the American Orthopaedic Association, Atlantic City, June, 1919.

This paper is presented with the idea of calling your attention to the fact that many people whose backs are injured in various ways in industrial occupations, suffer long periods of disability and incapacity from performing their usual occupations as a result of such accidents.

In looking over the records of a moderately large number of these cases one is impressed by two facts, first that the periods of disability seem unusually long in most cases, and second that the medical treatment and supervision these individuals have had has not been of the best, nor calculated to get the earliest and most adequate results, which would allow them to resume their work at the earliest opportunity.

This report covers one hundred and thirty-four cases, one hundred and twenty-four men and ten women. They have been divided into three classes as follows:

Class I. Those injured by falls of whom there are 61.

Class II. Those injured by direct blows in the back by falling objects, etc., of whom there are 31.

Class III. Those who have injured their back by lifting strains of whom there are 42.

These cases have been seen and studied individually by the writer at varying periods following the accidents and the results are presented as follows:

Class I—Injuries to the Back Due to Falls

This class comprises sixty-one cases, of whom fifty-two are men and nine women. The cause of the injury in all cases was a fall generally from a height varying from a maximum of seventy feet to a minimum of eighteen inches. These falls all resulted in back injuries of a greater or less degree, besides causing other accompanying injuries such as fracture of the arms, legs, etc. About half of these individuals were laborers, the others were divided up among factory hands, carpenters, masons, plasters, teamsters, butchers, roofers, telephone linemen, steel workers, painters, clerks, and houseworkers.

The details may be studied in Table I representing Class I.

In this class there were thirty-seven cases of contusion of the back complicated in some cases with fracture of the extremities, and a few with an accompanying or consequent hypertrophic arthritis of the spine. There were also twenty-four cases of fracture of the vertebrae. As may be noted from a study of the table, the injuries were severe, serious and consequently disabling for long periods of time, and in many cases resulted in permanent or at least partially permanent disability.

An analysis of these cases in regard to their known minimum periods of disability shows that in thirty-seven cases, leaving out the twenty-four cases of fracture of the spine, this period was 6.3 months. To include these twenty-four cases of fracture of the spine would be obviously unfair and would increase this average materially.

Taking the twenty-four spine fractures in Class I by themselves, the known minimum period of disability was 17.7 months. Class I as a whole including both groups above mentioned showed an average minimum period of disability of eleven months. The average age of this class was forty years. Here I might say that this average minimum by no means represents the actual period of real disability, either partial or permanent these individuals suffered, but only represents the time from the accident until seen by me as the impartial examiner for the Industrial Accident Board, at which time the great majority were still either partially or wholly incapacitated. Also it will be noted in the table that there is an occasional statement that there is no longer any disability existing. This is the opinion of the impartial examiner,

and is not made because the person is working, but because either from treatment or in spite of it, the examiner believes that he should try to go to work. The fact is the man has usually not gone back to work, except in occasional instances, but is still being paid compensation.

There is a peculiar mental state analogous to that so often seen in people suffering from litigation neurosis to be observed in many of these cases, which in my opinion delays their recovery.

In any fruitful discussion in regard to these accidents there should be found some reason as to why these cases, apart from the fractured spines, were incapacitated for so long a period. It is therefore my purpose to take up these thirty-seven cases, classified under contusions of the back and analyze their disability periods in terms of treatment. In order to do this, the cases were grouped as follows: Those that had what was to be considered as *adequate* treatment; those that had had *inadequate* treatment, and those that had had *no* treatment. Grouping the cases in this way it was found that the treatment was adequate in 17 cases with an average disability period of 6.8 months. Inadequate in 18 cases with an average disability period of 4.5 months. None, 2 cases with an average disability period of 17+ months.

Taking Class I as a whole the treatment was considered adequate in 25 cases, inadequate in 23, and none in 13. This shows that more than half the cases were suffering or had suffered from inadequate medical attention and is reason enough for the eleven months minimum disability resulting. A study of the cases as a whole showed that many of them were given a liniment to rub on the back; most of them were strapped once or twice at varying intervals with sticking plaster, and practically all of them were allowed to go their own sweet way, without any adequate follow-up system looking to their physical condition or proper medical attention. A number of the cases were discharged from hospitals without proper attention having been given to their backs in the way of proper support and without further advice as what was best to do or how to do it. Consequently they drifted. It is my firm belief that proper and constant medical attention in skillful hands would have cut the disability periods of these people in half.

The twenty-four cases of fractured spines represents another subdivision of Class I, and these again are cases of either perma-

nent or partially permanent disability. Only one case had the cord crushed and with a paraplegia was helpless, but lay around for twenty-two months before any treatment was suggested which would be of use to him. A number of others who had crush fractures of the vertebrae either went unrecognized and consequently untreated as such, for long periods of time, or were treated as sprained backs and strapped or furnished with a six inch belt for a supposedly sacro-iliac strain. Many crush fractures of the vertebrae left various hospitals unrecognized as such in spite of the individual's complaints, and without support for the back, in some cases as early as eleven days after the injury. Is it any wonder the disability periods are long and longer than they generally should be?

Another common condition complicating these back injuries is hypertrophic arthritis generally quiescent and pre-existent to the injury. The accident usually lights the condition up and so aggravates it. Without this complication the disability period might be short, with it the period is indefinitely lengthened and may be controlled only by careful and skillful treatment. The Industrial Accident Board is prone to recognize that an accident may and often does aggravate such a pre-existent condition and consequently the insurer has to pay compensation for the period during which the individual cannot work and has pain in the back. The presence of hypertrophic arthritis in a spine which presents a crush fracture of one or more vertebral bodies, may lead to confusion in the diagnosis in that the vertebral bodies may be so altered by the arthritic disease as to resemble a fracture and one cannot be too constantly on his guard in the interpretation of such X-ray plates.

I believe the American Orthopedic Association should go on record, or at least discuss the question of hypertrophic arthritis of the spine in relation to Industrial accidents. Can trauma cause arthritis as we see it; does it aggravate quiescent disease; what relation has its occurrence to compensation claims, etc.

It does not seem reasonable to the average individual to state that a contusion of the back without a fracture of the vertebrae would lead to a disability of probably 6.3 months. Yet it has been so in these cases. The answer I believe is lack of good medical care.

CLASS II— *See Table II*

Those injured by direct blows on the back by falling objects, etc., of whom there are thirty-one.

These cases suffered from muscle contusions as much as anything, apart from the fractures, and practically all had tender and irritable spines or backs. The injury was generally one to the soft parts. These accidents occurred to laborers, teamster, plumbers, chauffeurs, and factory workers, of whom the laborers and teamsters made up by far the greatest number, twenty-seven out of thirty-one. The average age was forty years.

A study of this series will show that the accident and injury was directly the result of their employment in most cases, and was an accepted hazard of their occupation. The types of accident were as follows: "Hit by boom of a derrick," "staging fell on him," "struck by falling timber," "caught in a trench cave-in," steam pipe fell on him," etc. In this class there were seven cases of fracture of the spine, including three crush fractures of the first lumbar vertebrae, one fracture of the cervical vertebrae, and one where the transverse processes of the lumbar vertebrae were fractured.

In Class II there are thirty men and one woman. The average age is forty years. The average time after the accident when the patient was seen by me was eight months plus, which represents the minimum period of disability. The treatment of these cases classified as before shows: Adequate three, inadequate twelve, none sixteen. Here again the cases with the exception of three fell far short of what they were entitled to in the way of treatment. In Class II there were seven cases of fracture of the spine. These fractures were the result of heavy objects falling on the patient's back. In no case was the treatment adequate; in four it was considered inadequate and three had no treatment at all. The disability periods reflect this lack of treatment very well. The average minimum period of disability in these cases inadequately treated was 14.7 months, and in those who had no treatment it was 20 months. The average period for the seven cases was 17 months which compares favorably with the fractured spines of Class I, where the period of disability was 17.7 months.

In order to give one an idea of my interpretation of the three terms, adequate, inadequate, and none or bad, I will describe the

treatment of three cases of Class II which come respectively under each one of these three groups. This will then allow the reader to judge for himself in regard to this method of classification.

1. Adequate Treatment.

This man hurt his back driving an automobile truck February 22, 1918. He was able to drive the rest of that day, but that night his back was lame. He began to have pain in the right leg on the inner side. His backache and pain still persisted, but was not severe enough to prevent him from working, and he continued to work until March 26th, driving passenger cars and doing garage work. The last three or four days that he was able to work he had severe pain in the region of the right hip. He had no medical attention up to the 26th of March, when he was told he had Sciatica. He then stayed in bed for eight weeks, with no other treatment except rest. He then was sent to the Orthopedic Department of a hospital, where X-rays were taken of his back, and a plaster jacket was applied which gave him so much discomfort that he took it off in a few hours. He was then sent to another hospital where he was put to bed on a frame, and later a jacket was applied which he wore until June 19, 1918. He was in the hospital for ten days. He has been working since June 19, 1918. His back is now stiff from fixation and he is strapped with sticking plaster. His treatment while delayed has been good on the whole.

2. Inadequate Treatment.

This man was hurt November 6, 1916, by a bag of flour falling on his back. After the accident he was taken to a hospital where his back was strapped, and he was kept in bed seventeen days. No X-rays of his back were taken. A plaster cast was then applied to his back which he wore thirty-two days. He has had no further treatment. I saw him July 30, 1917, about eight months after the accident. He has not been able to work and has a stiff painful back. An X-ray showed a crush fracture of the first lumbar vertebra. Obviously he needed support and treatment. An X-ray taken after the accident would have disclosed this condition. This man really had practically no treatment to which he was entitled.

3. Bad or None.

This man fell and had fall on top of him a lot of wet concrete on July 24, 1917. I saw him November 22, 1918, sixteen months later. He was taken home in a taxicab and called a doctor. He then went to a Jail Hospital where he stayed in bed seven months. He was there altogether ten months and twenty-four days. The only treatment he had was to have his back painted with iodine occasionally. No X-rays were taken, and when he got up he had to use two crutches. He still has a lot of pain in the back and down his leg. He needs support to the back, and would have been well long before if he had had it.

The instances shown in these three cases could be easily multiplied. It is not the general practitioner alone who is at fault. Hospitals have much to be blamed for in the careless methods of examination they allow their house officers to perpetrate and their visiting staffs to condone.

The question of treatment of these fractured spines is one of the greatest importance especially from an industrial point of view. Should they be treated as one would treat any fracture, that is, with a net minimum period of fixation, and then gradual use, or should they have a long period of fixation with plaster jackets and back braces, covering a year or two? Are we fixing them too long, or shall we be guided by clinical symptoms of a strained and irritable back, and continue fixation as long as these symptoms continue? Will increasing use begun early, say after three or four months, make a back more irritable, aggravate the callous already present, increase the symptoms, and possibly lead to nerve pressure from new callous formation, or will such use properly restricted lead to earlier restoration of usefulness and function? These are the questions we should be able to give an answer to.

Class III is represented by those cases who injured their backs by lifting strains, generally acquired by trying to carry or lift some object much too heavy for them. The diagnosis of back strain was made in the majority of the cases. The term back strain is used advisedly, for any definite classification of these cases is difficult. The majority apparently had received muscle or ligamentous tears involving the fibres of the erector spinae group of muscles, the deep spinal ligaments or the liga-

ments which are inserted about the sacrum or sacro-iliac joints. Very few showed the typical signs of a true sacro-iliac strain although it did exist in some cases but was definitely in the minority. As a rule definite back support is needed for a while, and is not supplied by a six inch canvas belt loosely applied about the pelvis.

There were 42 men in this class with an average age of forty years. The occupations were various and are indicated as follows: Laborers, bakers, carpenters, machinists, boat builders, steam fitter, janitor, iron moulder, grocery clerk, teamster, etc. All were individuals who have heavy lifting to do as a routine in their work. The average minimum period of disability was 5.9 months, which is better than either Class II with a minimum of 8+ and Class I with a minimum of 6.3 months. This is natural as the injury is generally less severe. The treatment was considered adequate in twelve, inadequate in twenty, none in ten. In all classes, 1, 2, and 3, the treatment was shown to be as follows: Adequate, forty; inadequate, fifty-five; none, thirty-nine, which shows a preponderance of ninety-four in favor of those cases which suffered prolonged periods of disability as a result of lack of medical attention and treatment.

Again to show the type of case and the methods of treatment as generally applied I will quote briefly one for each group from Class III.

Group A. Adequate Treatment.

This man was hurt May 17, 1917. I saw him March 22, 1918. He strained his back lifting an iron beam. Since then he has been unable to go back to work as a carpenter on account of persistent pain in the back. After the accident he went home to bed and stayed there a week, and had his back strapped. He then went to a hospital where a plaster cast was applied, which he wore three weeks. He went to work when this was removed, but had to stop after two days on account of pain in the back. He then had a belt made for him at the hospital which he has worn ever since. He has had some massage at the hospital, but had to stop that on account of its expense. He then went to another hospital and was told to do some back exercises. He can't work now on account of pain in the back and is selling papers to make a living.

Group B. Inadequate Treatment.

This man strained his back October 21, 1918, attempting to lift a heavy scoop. He had to stop work and was taken to a hospital where he stayed a week, and where an X-ray was taken of his back. His back was strapped for a week. Since then he has had no treatment except some liniment which he has bought, and is taking some medicine which was given him by some friends. He is still incapacitated, a month later, and is having no treatment.

Group C. Bad or No Treatment.

This man hurt his back lifting a barrel May 25, 1917. I saw him August 22, 1917. He has done no work since the accident. He wore one strapping for a month, since when he has applied porous plasters. He has had practically no medical attention. His back is stiff and painful and needs support. He is still incapacitated.

It would seem as if the cases in Class III should show a much greater difference in the period of disability than either of the other classes by a marked degree, but they do not to the extent expected. What is the reason? To my mind it again comes down to lack of adequate treatment, properly and carefully carried out and followed up. Back strains are generally made light of, and strapping with sticking plaster seems to be the usual treatment. It however is apparently not enough in the way of adequate treatment or it is not properly applied so as to give good support. Strapping properly is an art, and should be done with a clear conception of what is to be accomplished mechanically, or it fails. These cases should be entitled to as good care as others with more severe injuries, and the treatment supplemented by massage, baking, etc. To my mind the first requisite is control of the patient, which it is so far obvious the free choice the patient has of physicians under the law does not supply. Either the cases must show better results from treatment, or the medical profession will fall down grievously. The Industrial Accident Board has the means of checking up each and every man practicing medicine in Massachusetts, and it behooves each individual to make good, or some readjustment in regard to the treatment of these industrial cases will have to be made. Careful and adequate physical examination will lead to more comprehensive treatment, and is an essential all too often neglected.

If this report serves only to awaken the medical profession to the dangers of new legislation likely to come because of the neglect of these industrial accidents it will have served its purpose. We have reached the stage where our work is individually being checked up and we must make good.

Discussion

Dr. Griffiths said that he had personally suffered such an accident 9 years ago, while driving in a limousine, he was thrown up to the top of the car and bounced back again. He struck the seat very hard in coming down and intense pain was felt in the whole spine. He was 8 miles from a hospital, but drove there and went to bed. It was recognized that the 12th dorsal and first lumbar vertebrae were seriously hurt. He had the house surgeon strap him two-thirds of the way from the anterior superior spine, nearly up to the shoulders. He stayed in bed three or four weeks. When he got up he had no trouble in the legs and did not think of fracture. Then he went on a trip to some meeting and stopped to see brother John Ridlon, who said there was a fracture of the spinous process. After that the thing began to bother him very much. (It did not do to inform patients that they were injured). The speaker said he went to New York and saw Dr. Shaffer, who said there was a bad fracture, after which he commenced to feel very bad. Dr. Shaffer made a brace, which was worn for 12 months, taking it off at night. He was able to do his office work without any trouble. Any time that he did too much he felt the effect of the injury. Although these injuries to the spine might be severe, the patient could get along with a little assistance.

Dr. John Ridlon, of Chicago, said that they had been taught not to expect tuberculosis to develop on the site of an injury. He had seen two recent cases of industrial injury, with fracture of the bodies of the vertebrae. Fractures were not recognized and within two months tuberculosis had developed on the site of the fracture.

Dr. S. C. Baldwin, Salt Lake City, said that the early diagnosis of these cases was important. One important point was putting them up on an inclined plane with a Sayre's extension apparatus. One case at Chateau Thierry, shot all to pieces in the left shoulder and neck, with a big sinus in the neck, and when he turned his head to the right the right pupil dilated. He was put in an extension apparatus and in 5 weeks was relieved of the neck symptoms and the sinus closed. These injuries result in fracture and displacement of the articulatory surfaces of the bodies of the vertebrae. Diagnosis was a very important point.

Dr. J. W. Sever, in closing, said that early diagnosis was important, and the cases ought to see orthopedic surgeons earlier. Of 50 cases seen, only ten had an early diagnosis. In one girl there was complete paraplegia of both legs and retention of urine. She was being treated for hysteria and was catherized for 9 weeks. Proper men should see the cases early. In rgard to inlay graft, Dr. Brackett had done many cases. If they were done early they might hasten recovery. It was a mistake to let the idea of a fractured spine become fixed on a man's mind. The psychology of these cases was a definite entity. One man went to pieces entirely when he was shown the X-ray, although he was not so much shaken by the injury. One should be careful in placing these cases before a jury. If one said fractured spine they supposed it something terrible. What Dr. Watkins said about putting the man to bed was true, if one knew there was fracture, but often one did not know.

Dr. H. P. H. Galloway said that this subject was of such great importance, that he would suggest that it be given a prominent place in the program next year. There were an incredible number of back cases returning from the war. In the question of pensions this would be of great importance.

THE TREATMENT OF FLAIL JOINTS OF THE UPPER LIMB FOLLOWING GUN-SHOT INJURIES.

By Harry Platt, M. S. (Lond.). F. R. C. S., (Eng.), Hon. Surgeon and Surgeon in Charge Orthopaedic Department Ancoats Hospital, Manchester, Capt. R. A. M. C. T. F., Orthopaedic Surgeon in Charge, Special Military Surgical Hospital, Grangethorpe, Manchester.

(Paper Opening a Discussion Before the British Orthopaedic Association, May 30, 1919.)

The flail joints of the upper limb following gun-shot injuries are amongst the most difficult problems in military orthopaedic surgery. In these brief introductory remarks I shall confine my attention to the shoulder and elbow joints as no case of flail wrist joint has chanced to come under my care. Furthermore the type of flail joint under consideration is the one dependent on an actual loss of bone and not that type which is secondary to a severe paralysis of muscle groups in the region of the joint. For obvious reasons this latter type of flail joint has been rarely seen in war injuries.

It is instructive to trace the actual evolution of the flail joint. The vast majority of the cases seen in the military orthopaedic hospitals are those in which a wide excision of the articular ends of the bones has been carried out in the early stages after the infliction of the wound. Such radical procedures were apparently practised as a routine measure, and as limb saving and life saving operations were undoubtedly justifiable. In this connection we cannot criticise them.

Unfortunately it is by no means rare to see flail joints, generally elbow joints, which have followed formal excisions performed for ankylosis. Such results demand criticism in no measured terms.

Although we must admit that the anatomical conditions predisposing to the development of a flail joint were provided in every case in which an extensive resection of the damaged articular ends was performed, yet it is difficult to believe that the flail joint was always inevitable. There can be little doubt that if the importance of correct postural fixation of the limb in the intermediate stages

after the subsidence of the more acute sepsis had been universally realised, many of these joints would have presented in the late stages, fair stability with a little motion or sound ankylosis in good position. I do not need to emphasise this aspect of the subject as preventive measures are now of course inapplicable to the problem under consideration.

Shoulder Joint.

Anatomical conditions. In practically all cases of flail shoulder joint, the head of the humerus has been removed entire, the line of section passing well below the tuberosities. Where the destruction of the periosteum has been small, abortive attempts at a reconstruction of the upper end of the bone are sometimes seen, manifested by the upgrowth of one or more bony spikes. In this type of case one finds that the instability of the joint is often of a degree less than that which characterises the flail joint proper.

The acromion, coracoid, and glenoid fossa are in most cases intact. The deltoid muscle rarely escapes direct involvement, atrophy, actual loss of origin, and partial or complete replacement by fibrous tissue being the rule. The recognition of the presence of an active deltoid muscle and an estimation of the degree of its future functional capacity after a period of suitable treatment, are important factors in determining the type of operation to be adopted for the disability.

II. Treatment.

Every case requires separate and special consideration particularly in regard to the functional capacity displayed by the scapular muscles and deltoid. The success of any operative procedure will depend ultimately on the development of muscular sufficiency and co-ordination. Theoretically given a deltoid capable of a moderate degree of function and with normal scapular muscles, joint stability should be possible of attainment without the production of an ankylosis, but I believe that in all cases a fixation of the shoulder joint should be aimed at. An incomplete fixation, i. e., allowing a slight degree of "give" or a small range of true motion often affords a perfectly satisfactory functional result. This is fortunate as the operative production of bony ankylosis at any rate in my own experience, has been an exceed-

ingly difficult feat. Before any operation is undertaken the usual preliminary physio-therapeutic treatment must be given. The arm should be maintained on an abduction splint and intensive training of the scapular muscles—and of the deltoid, if this is possible —must be carried out. During this period of training a certain degree of stability may develop in the joint and in one or two cases in my series actual operative fixation has been rendered unnecessary by a sufficiently prolonged period of physio-therapeutic treatment.

Furthermore I believe that any operation should be performed in two stages. In the first stage, the adherent skin scars should be exsected, the glenoid fossa and upper end of the humerus exposed and the whole block of scar tissue removed for bacteriological examination. In addition at this stage an actual reconstruction of the deltoid insertion can be effected and the result of the direct faradic stimulation of this muscle noted for future guidance. The second stage operation which as I have indicated should be designed to produce fixation may be of two types, (a) classical arthrodesis, (b) reconstruction of the head of the humerus. The traditional arthrodesis operation necessitates considerable trimming of the upper end of the humerus and therefore an additional sacrifice in a bone which is already all too short. The stump of the humerus must be brought into contact with the bared glenoid cavity and also slung up to the acromion and coracoid in some fashion. In my own experience with this operation which I adopted in the earlier cases of flail shoulder joints, bony ankylosis or even stable fibrous ankylosis was exceedingly difficult to obtain. In three cases only out of some fifteen arthrodesis operations have I obtained a stable fixed joint and in none of these was actual bony ankylosis present. It has been suggested that if an arthrodesis operation is followed by a recrudescence of sepsis, ankylosis would be more certain than if primary healing was obtained. This has not been my experience.

The operation of bone lengthening or reconstruction of the head of the humerus I have now adopted as a routine procedure in the flail shoulder joint. In an attempt to reconstruct a new head of the humerus in order to fill up the gap and to provide a fulcrum upon which the arm can be steadied by the combined action of the scapular and deltoid muscles, one hoped at first that a shoulder joint allowing actual independent motion would be produced. I

believe however that the success of this operation depends entirely upon the development of fixation of the joint—not necessarily complete—but for practical purposes a fibrous ankylosis. For this operation I adopt the following technique. A large autogenous graft is removed from the tibia shaped like a wooden mallet. The shoulder joint is exposed, the upper end of the humerus cleared and the handle of the graft driven into the medullary cavity: The wide upper end is now brought into contact with the glenoid cavity which has been completely bared as in an ordinary arthrodesis operation. In two cases to afford additional support I have used a long fascia lata sling carried through the upper end of the humerus, the upper margin of the glenoid and the acromion process. After completion of the operation the limb is put up in 90° abduction and this fixation is maintained until stability of the joint has

Fig. 2.—Private B.
Result of bone graft operation for flail shoulder joint. Date of operation, July 3, 1918.

Fig. 1.—Private B.
Result of bone graft operation for flail shoulder joint. Date of operation July 3, 1918.

developed. I have performed this operation in six cases, two of which have been done for a sufficiently long period to demonstrate the maintainance of the useful functional capacity which has resulted. (Fig. 1, 2 and 3.)

This operation, which is still under trial, is, I feel, well worth while.

1. Elbow Joint.

Anatomical conditions. In the flail elbow joint the line of section of the humerus is almost invariably well above the condyles; the olecranon is always missing, but the head of the radius in many cases has been left intact. Fusion of the upper ends of the radius

and ulna is also commonly seen in many of the elbow joints. Coexisting lesions of the median and ulnar nerves or even in some cases the musculo-spiral often complicate the problem of the disability. The stability of primary excisions of the elbow vary considerably and many cases hardly fall into the class of true flail joints. The definition of a flail elbow joint is not easy but one uses as a rough test the ability or inability of the patient to hold the forearm in the horizontal plane when the shoulder is abducted to 90°

In the true flail joint the forearm falls vertically in a limp fashion. Before any operation is performed a course of preliminary physio-therapeutic treatment is necessary in these cases. The elbow should be slung up in acute flexion and the bones approximated as closely as possible by the application of strapping. During this time training of the biceps muscle is undertaken and if the period of fixation is prolonged enough, actual shortening of the biceps will take place and become of great advantage to the future function of the limb.

FIG. 3.

X-ray of Private B. Graft in situ; nine months after operation.

FIG. 4.—Private M.

Flail elbow joint. Operation—fascia lata slinging. Date of operation, October 17, 1918.

2. TREATMENT.

The question as to whether ankylosis of the elbow joint in a good position is advisable or the retention of a movable joint with moderate stability, is one that can only be decided after a study of the anatomical conditions present and a knowledge of the past

or future occupation of the injured man. In my own experience, most of the flail elbow joints have been accompanied by serious co-existing lesions of the soft tissues and such limbs can only be made useful for very light duties. In many cases an ankylosis is the most desirable procedure but true bony ankylosis is very difficult to obtain with such small bone ends, presenting as they do an exceeding degree of atrophy. Operations devised to obtain stability with the retention of motion may be divided into two classes, (a) those in which simple approximation of the bone ends is obtained, (b) in which an increase in the length of the humerus is obtained by the insertion of a graft as in the shoulder joint operation described above. For some time I have been carrying out in picked cases an operation belonging to the first class, which consists essentially of binding the bone ends together by the insertion of one or two long stout slings taken from the fascia lata of the patient's thigh. The lower end of the humerus and the upper ends of the radius and ulna are drilled and the two artificial ligaments carried through in planes at right angles to each other, tied securely, the knots being fixed by thread sutures and then the ends of the ligaments fixed to the remains of the joint capsule and the muscle insertions in this region. The limb is slung up in 45° flexion and a period of after training of the same character as the preliminary training is carried out. Active flexion within a small range is encouraged at an early stage, the upper arm being retained in contact with the body; when stability from the position of 90° to full flexion is present, training is instituted in the position of abduction at the shoulder, the development of the stability in this position being a test of the operation. In half a dozen cases in which this operation has been carried out a useful degree of stability has developed. (Fig. 4.) I would emphasize the fact in connection with the operative stabilisation of the elbow joint that the end result depends entirely on the development of muscular control.

PERSONAL EXPERIENCE IN THE USE OF LANE PLATES

PAUL P. SWETT, M. D., F. A. C. S.

Out of a total of 1,560 fractures of the long bones observed during the past three years, there have been 172 open operations. Forty-one of these were compound fractures and 129 were for the reduction and direct fixation of simple fractures, delayed union, non-union and vicious union. Lane Plates were applied in 28 instances. So much has been heard by way of intimation with regard to the disastrous effects of the plates that it seems high time for a definite record of a series of fractures treated by means of plate fixation.

In this group of 28 fractures the distribution was as follows:

Femur: 18 instances.

Tibia and Fibula: 7 instances.

Radius and Ulna: 3 instances.

Primary healing of the operative wound was obtained in every case except on two occasions when the plates were used at the primary cleansing operation on compound fractures. I realized at the time that it is not sound surgical practice to introduce foreign materials into the wound in compound fractures but the displacement was so severe in both of these cases that I felt justified in taking the risk. However, the infection in either of these cases may have had no relation to the plates and, furthermore, excellent end results were obtained following the prompt removal of the plates.

In four cases sinuses have developed at the end of 6 to 10 weeks. In all of these instances the process was afebrile and seemed to be merely the result of foreign body irritation. The plates having accomplished the objects of their use, were promptly removed and the sinuses immediately healed in all but one case. This was a tibia and union of the bony fragments was delayed for 3 months during which time the sinus persisted. This, it seems to me, was a positive example of low grade osteomyelitis caused by the use of a plate and it is the only occurrence of its kind in the entire series. The most probable explanation of this misfortune is that the plates and screws were handled by the

operator which is entirely out of order and never necessary. Overconfidence in the method and lack of sufficient assistants account for this break in technic.

No cases of non-union, delayed union or vicious union have occurred in the entire series. During the past two years all of the patients have been advised to have the plates removed as soon as strong union of the fragments was accomplished and this with a view of preventing any late ill effects. This procedure has been carried out in four cases. It is interesting to note that no kind of abnormal soft tissue or bony reaction was found in any of these cases.

In one case of non-union of the femur operated upon 1½ years after the injury a large 6 screw plate was used and, in spite of the many protests against this particular procedure, a most excellent result occurred. The fact that excessive overlapping of the transverse fragments made it necessary to remove considerable bone, with the resultant apposition of healthy non-sclerotic fragments is the explanation of this success.

The two cases of infected compound fractures and the four cases of sinus discharge all occurred in the radius and ulna or the tibia and fibula. In other words there has never been the least trouble in any of the femur fractures which even includes one compound case. This observation has struck me very forcibly and I have concluded that the greater depth and extent of the muscle layers surrounding the femur provide a much stronger resistance than do the thin tight tissues in the leg and forearm Hence plating seems to be a much safer procedure in the femur than in other localities.

As a result of this experience I feel warranted in concluding that Lane Plates offer a highly satisfactory, safe and efficient means for securing the direct fixation of bony fragments in properly selected cases. On account of their facility of application they are particularly desirable in severely comminuted fractures where they seem mechanically more efficient than other agents and where the introduction of other fixation materials is likely to further increase the trauma.

Discussion

Dr. J. Torrance Rugh, of Philadelphia asked how the parts were held.

Dr. Rugh said the last point was one of the most important. The tissues would tolerate a certain amount of manipulation, but beyond that point they would break down. That was shown in all forms of metallic suture. Personally he was not partial to foreign substances. He placed more reliance in external fixation.

Dr. T. Halsted Myers, of New York, said he had had a case of Congenital dislocation of the hip in which an anteversion of the neck had prevented the reduction from being permanent, and he had divided the femur 2 inches below the great trochanter, rotated the lower fragment, and to make sure the leg would not re-rotate, put a plate in for three months; after this it was removed. In cases requiring an exact apposition a temporary plate was satisfactory.

Dr. Paul P. Swett said he did not hold a brief for the Lane plate, but he had had 216 fractures of the femur and in 18 cases it seemed to be the best method. He had not come to a conclusion as to whether to use more or less plates.

APPLICATION OF CURATIVE THERAPY IN THE WORKSHOP

BY EUGENE B. MUMFORD, CAPT. M. C., U. S. A., CHIEF OF ORTHOPEDIC SERVICE, BASE HOSPITAL, CAMP ZACHARY TAYLOR.

The purpose of this paper is not to discuss the actual detailed work done in the workshop. The special exercises and devices are only too familiar to you all and nothing new was developed in the clinic at the Base Hospital, Camp Zachary Taylor. It is the desire to present to you the plan of the organization of the non-operative work of the hospital and to show the apparent success of the close cooperation of the Orthopedic Department with the Educational and Physio-therapeutic Departments.

The plans of the War Department placed the reconstruction phase of the care of the crippled soldier under the supervision of the Educational Department, the officers of which are members of the Sanitary Corps and practically all of whom have had none, or little training in medicine and surgery. To them was delegated the gymnasium, manual training, and bed-side work. In turn the massage and allied clinics under the name of Physio-therapy were delegated to the Psychiatric Service. The classification of the cases falling to the Orthopedic Service has been at all times most indistinct and varied with the ideas of the individual Chief of the Surgical Service. At least such was the case at Camp Taylor.

After a survey of the character of the work found at the hospital a conference was held by the Chiefs of the Educational, Phychiatric and Orthopedic Departments and the conclusion reached that the primary purpose of the hospital was curative and that the education of the patient was at all times to be considered as of secondary importance. It was also determined that most of the peripheral nerve lesions would fall to the Orthopedic Surgeon and thus, with the other deformities resulting in loss of function, the services of the Physio-therapy Department would be used more by the Orthopedic Surgeon than by any other medical officer. As a result of this conference it was determined that though these phases of the Educational and Physio-therapy Departments would remain nominally under the Chiefs of those Services, the Orthopedic Service would be given practical control and could plan its work accordingly.

The types of cases at the hospital were the usual ones found in Base Hospitals, including all classes except amputations. Of the acute and operative phase of the work nothing shall be said. It was the chronic and non-operative, including healed post-operative cases that came to the work shop for further treatment, those cases of injury to the bones, muscles, tendons or nerves with associated loss of joint function and muscle power. It is not necessary to give a detailed clinical picture of these injuries which must be so well known to everyone.

The cases at first were scattered throughout the hospital area and found in practically all Services. Many had been in the hospital for several months, having been shifted from one ward to another and thus falling under the care of many different ward surgeons. The briefs did not show any accurate data as to the extent of the disability upon admission nor as to the changes while under treatment. As a rule only the patient could tell whether improvement had resulted and even then it was often a matter of guess. They were an uninteresting lot of cases to the average army medical officer who was holding them until time would so stabilize the lesion that they might be discharged with disability of a maximum degree.

These cases were collected into separate wards and placed under the care of an Orthopedic Surgeon. The gymnasium and the workshop, which were supervised by a trained gymnast and an expert manual training teacher, were placed under the direction of an Orthopedic Surgeon having full control of the schedule in each of these clinics. The following plan was then adopted for the handling of the crippled patient who had been classified as non-operative, or upon whom operative work would be postponed for several weeks or months.

Upon admission to the ward the usual brief was made out by the ward surgeon and the patient was sent immediately to the Orthopedic Surgeon at the workshop. Here a record card was compiled which gave the name of the patient, ward, date of admission to the Orthopedic Service, a brief description of the wound, the nature of the disability, the range of motion in the affected joints and the amount of power in weakened muscles. Notation was then made as to the treatment prescribed, as "elbow, right, flexion and extension, moderate." This card also showed the daily schedule of work of the patient.

Especial attention was given to the accurate recording of the disability. By means of special protractors the actual range of motion in the disabled joint was determined and in order to have a standard, the range of motion in the opposite and well joint was recorded in each case. The same record was made in regard to muscle power.

The patient was then given a schedule card which designated the hours of the day at which he was to report to the various clinics, this card to be kept by the patient in order that should he be picked up about the hospital area during working hours he would not have the usual excuse of "I forgot." After the Orthopedic Surgeon had finished his record the patient was then sent to the Educational Officer who enrolled him in one or more classes, noting hours upon the schedule card of the patient. Cooperation was thus maintained between the Educational and the Orthopedic Departments.

As the Physio-therapy Department was under the supervision of the Orthopaedic Surgeon all assignments to those clinics were made at the time of the first record taking. Thus the patient had four different clinics to fill up the day, Gymnasium, Workshop, Massage and Vocational or Educational. In order that the sections would be equally divided and no one overcrowded, the appointment of the hours was made by the Orthopedic Surgeon. The day was divided into two periods, the morning and the afternoon, and these were again subdivided into two equal periods. The assignment to the workshop filled an entire period of two hours as it was found possible to keep the men at work there for a much longer time than in the gymnasium. The gymnasium and the physio-therapy occupied but a subdivision, each being of an hour's duration. This arrangement left one hour in the morning and one hour in the afternoon to be occupied by the Educational work.

The keynote of the whole plan was the direct and personal supervision of all the work done in the gymnasium, workshop and massage clinics by an Orthopedic Surgeon. In the gymnasium the schedule as planned by the trained gymnast consisted of ten minutes of setting up exercises followed by twenty minutes of special work in which individual attention was given by the surgeon in seeing that the disabled part was being properly exercised. The exercises used were of the orthodox type and here as well as in the other clinics nothing new was developed. The last half hour of the

period was devoted to the playing of games. Here again some effort was made towards specialization in that the games were arranged for different types of cases, the shoulder cases playing volley ball, the wrist cases throwing hoops, etc. A shower bath with a brisk rub finished this part of the work.

In the workshop the surgeon gave the same personal supervision. The manual training feature of the work was under the direction of an expert in that line of work but all along the educational side was made secondary to the curative side. It was not so much a matter as to what the patient produced with certain tools nor how soon he finished a particular article. It was impressed upon him that a poor article made with the crippled hand would get him out of the hospital in a shorter time and with less disability than if he had made a better article with his well hand. This personal supervision of the patients during their time in the workshop is absolutely necessary in order to obtain the desired results. The patient otherwise, becomes absorbed in his work and involuntarily he will shift the tools to the well hand in order to do better and faster work. All machines, as lathes and saws, were foot or hand power, that the exercise feature of the work might always be present.

The massage and allied clinics were also given the personal supervision of an Orthopedic surgeon. The men were divided into six sections and one section was observed each day and thus each case was seen in this phase of the work each week. Theoretically the massage should be given before the patient goes to the gymnasium or workshop, but practically this is impossible when dealing with a large number of cases.

Each week the patients were remeasured and the results tabulated upon record cards. If the examination did not show any gain a survey of the case was made in order to determine whether the patient was attending the clinics regularly and if so whether or not he was working in the exercises in a conscientious way or the exercises prescribed were suitable to that particular case. If the case seemed to have reached the maximum improvement as shown by the weekly examinations the patient was ordered to appear before the Chief of the Orthopedic Staff for recommendation that he be sent before the Disability Board for discharge. This recommendation was made in the form of a progress sheet containing data of the examinations and with the note that maximum im-

provement had been reached. This sheet was taken to the ward surgeon who then prepared all other necessary papers and sent the patient before the Disability Board. This progress sheet is of great value to the Board in that it furnishes accurate data as to the course of the patient in the hospital and also gives them the exact number of degrees of motion in the affected joint and also in the corresponding well joint in the same patient.

At first the morale of the patient was not very good and it was hard to convince them that the simple exercises would be of any value. Many had been in the hospital for a long time without having had any intensive treatment while others had come from camps and hospitals with the notation that maximum improvement had been reached. A few realized that they would improve in time and were willing to go out with their existing disability. In order to have regular attendance a roll call was made at the beginning and at the end of each period. Those who were absent were ordered through the ward surgeon to report the following day at the office and unless a good excuse could be made, disciplinary measures were taken. However, this detail of the plan was soon found to be unnecessary for the patients realized that we were working not only for their improvement in function, but also for their early discharge from the army. They became interested in the results of the weekly examinations and took a personal pride in the gains that were made. The fact that they could not be discharged until they had satisfied the Orthopedic Department that maximum improvement had been reached may also have been an important factor in the regular attendance.

The facilities of the workshop were made accessible to all Departments of the hospital without the transfer of the patient to the Orthopedic Service and the same data furnished as to our own ward surgeons. In order that no case should be lost or over-looked the Orthopedic ward surgeons were instructed to call the attention of the surgeon in the shop to any cases that might seem to them to have reached maximum improvement. This is but an added check to facilitate the early discharge of the patients.

It has been interesting to note that under careful exercise some of the cases seemed to go backward and to lose in range of motion. However, by giving them a week or rest they would return to show at the first examination a greater range of motion than at any previous time. No doubt we had to deal with a muscle spasm pro-

duced by over exercise. In 185 cases of all types 149 showed a gain of 2471 degrees of motion in the joints while 36 registered a slight loss or not any gain. An average gain of 14 degrees was made in the elbow cases, 34 degrees in the shoulder, 35 degrees in the hip, 14 degrees in the ankle, 16 degrees in the knee and 18 degrees in the wrist cases. The wrist cases were most apt to show a loss. In 16 cases 370 pounds were added to the muscle power.

The basis of the workshop therapy at Camp Taylor was intensive treatment under close supervision by an Orthopedic surgeon. It has been of value not only in a curative way, but has also hastened the discharge of the patient and thus lessened his hospitalization period, saving money for the Government and returning the soldier to civil life at an earlier date. The work in the gymnasium was not only of value to the local lesion and disability but also improved the general physical condition and stimulated an interest in gymnastics which I hope the patient will carry into his home town. The same is true of the carpenter shop, the auto repair shop and the bedside work of the Reconstruction Aides. In all of these clinics the patient was taught things to make him a better and more useful citizen. And I feel sure that the psychiatrists will agree with me that many patients, by having a day full of interesting work, were saved from a life of insanity into which they were being gradually led through the incessant grind of the electric piano in the recreation centers.

Announcement

Back numbers and volumes of the American Journal of Orthopedic Surgery are now available for distribution. With the greatly aroused interest in reconstruction surgery no more valuable collection of literature can be found than this series of publications by the American Orthopedic Association. A certain number of these volumes will be offered for sale, but complete sets can no longer be had. At present, and until the supply is exhausted, any volume of the American Journal of Orthopedic Surgery from II to XIV (1903-1915) will be sent complete upon receipt of five dollars ($5.00). The volumes for 1902, 1916, 1917, 1918 cannot be had, although certain odd numbers for these years may still be obtained.

It is especially urged that members of the surgical profession who desire either for themselves or for libraries in their vicinity any comprehensive collection of Orthopedic literature should promptly subscribe for the volumes from two to fourteen or any odd numbers in this series which they do not have at present.

Promptness is suggested as the comparatively few volumes available will undoubtedly be exhausted within a short time. Odd numbers of these volumes will also be sent at $1.25 each. All copies or volumes ordered at these prices with an accompanying remittance will be sent prepaid.

Editorial

NOTES ON THE HISTORY OF ORTHOPEDIC SURGERY.

Mr. William Adams and Mr. Maunder before the Royal Medical Chirurgical Society, October 10, 1876, discussed subcutaneous division of the neck of the femur. Several cases were reported, in which the Gant operation as well as division of the neck and of the shaft below the great trochanter were employed. There were twenty-two cases in all with two deaths.

The interesting fact was mentioned that Sir Charles Bell in 1828 had proposed subcutaneous division, with a small saw, of the neck of the femur in the early stages of hip disease. It was his idea that the head of the bone would thus remain at rest in the acetabulum and a movable false joint formed at the point of osteotomy. Sir Charles Bell pointed out that such an operation would be attended by small risk. There is no record that he ever performed this operation, but it is a matter of interest that his suggestion was made three years before Stromeyer's operation of subcutaneous tenotomy.

Mr. Adams mentioned in his concluding discussion that he preferred section of the neck of the femur to the Gant operation except when the head and neck had been extensively damaged. Also in operations upon the neck there was a chance of fibrous ankylosis with a false joint. The safety of the procedure is suggested by the fact that the twenty-two cases reported with but two deaths were from the practice of twelve different surgeons.

The above remarks are based upon a report by the London Lancet of October 14, 1876.

Items of Interest to Orthopaedic Surgeons

Dr. John Allan Talbott has resumed practice, limited to Surgery of Extremities and Spinal Column (Orthopaedic Surgery), 1621 Connecticut Avenue, Washington, D. C.

Dr. Philip D. Wilson, lately consultant in charge of amputations, A. E. F., announces that he has reopened his office at 106 East Broad Street, Columbus, Ohio. Practice limited to surgery.

Dr. Lawson Thornton announces his return from active service with the army and his association with Dr. Michael Hoke in the practice of Orthopedic Surgery with offices at 15 West Alexander Street, Atlanta, Georgia.

Dr. H. J. Dauterive, who was on duty at Chateauroux and Savenay, has returned from overseas. Office 621 Macheca Building, New Orleans, Louisiana.

Dr. Maynard C. Harding desires to announce that he has returned from service and resumed his practice at Suite 701 Timken Building, San Diego, California. Orthopaedic Surgery.

Interallied Conference on War Disablement.—The third interallied conference for the study of problems relating to war cripples was held in Rome, Italy, October 12 to 17.

The Distinguished Service Medal has been awarded to Colonel Webb E. Cooper, Medical Corps, U. S. Army. The citation reads: "For exceptionally meritorious and distinguished services. He commanded with notable success Base Hospital No. 8 at Savenay, which under his efficient administration became the nucleus of a large hospital center, which developed into the largest classification and evacuation hospital in France for patients returning to the United States. By his marked ability in directing the numerous activities under his control he rendered services of conspicuous worth to the American Expeditionary Forces." To all those who knew Colonel Cooper at Savenay this announcement will give the greatest satisfaction.

Orthopaedic Titles in Current Literature

ACETABULUM FRACTURE, with Intrapelvic Displacement of Femoral Head—Peet, M. M.; *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 296.

AMPUTATION, Open, Through Knee Joint—Smith, M. K.; *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 287. Abst. *Jour. A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1160.

AMPUTATION, Reason for Early—Brachet, H.; *New York Medical Journal*, August 23, 1919, Vol. 110, No. 8, p. 327.

AMPUTATION STUMPS, Complications—Little, E. M.; *Journal of Orthopaedic Surgery*, August, 1919, Vol. 1, No. 8, pp. 457, 458.

AMPUTATIONS AND AMPUTATION STUMPS—Forbes, A. M.; *Medical Council*, Philadelphia, October, 1919, Vol. 24, No. 10, p. 761.

AMPUTATIONS, Cinematic, Report on—Gallie & Gunn; *Canadian Medical Association Journal*, August, 1919, Vol. 9, No. 8, p. 694. Abst. *Journal of Orthopaedic Surgery*, October, 1919, Vol. 1, No. 10, p. 637.

AMPUTATIONS, Lower Extremity, Treatment of—Yount, Carl C.; *New York State Journal of Medicine*, Vol. 19, (1919) No. 9, pp. 339-343.

ARTHRITIC DIATHESIS—van Breeman, J. L.; *Nederlandsch Tijdschrift v. Geneeskunde*, Amsterdam, July 5, 1919, No. 1, Vol. 2, p. 4. Abst. *Journal A. M. A.*, October 4, 1919, Vol. 73, No. 14, p. 1097.

ARTHRITIS, SUPPURATIVE—Netter, Mozet and Salanier; *Presse Medicale*, May 29, 1919. Abst.: *New York Medical Journal*, September 20, 1919, Vol. 60, No. 12, p. 521.

ATLAS & AXIS, Injuries of—George, A. W.; *Boston Medical and Surgical Journal*, Boston, September 25, 1919, Vol. 181, No. 13, p. 395. Abst.: *Journal A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1160.

BACK INJURIES, Disability Following—Sever, James W.; *Journal American Medical Association*, September 6, 1919, Vol. 73, No. 10, p. 787.

BONE FISTULAS After War Wounds—Chutro, Pedro, *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, pp. 751-753. *Journal Orthopaedic Surgery*, September, 1919, Vol. 1, No. 6, p. 521.

BONE FISTULAS, Discussion of Papers—Eastman, Smith and Knight; *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, pp. 753-4.

BONE GRAFTS, Some Points On—Wheeler, W. I. de C.; *Dublin Journal of Medical Science*, Dublin, July, 1919, Third Series, No. 571, p. 12.

BONE, SEPSIS of,—Gallie, W. E., *Journal of Orthopaedic Surgery*, Vol. 1, August, 1919, No. 8, pp. 465-92.

BONE SUBSTITUTE, Rubber Implants,—Delbet, Girode and Contremoulin; *Bulletin de l' Academie de Medecine*, Paris, July 29, 1919, Vol. 82, No. 29, p. 110. Abst.: *Journal A. M. A.*, September 27, 1919, Vol. 73, No. 13, p. 1016.

BONE WOUNDS, Treatment of Infected,—Cotton, F. J.; *Boston Medical and Surgical Journal*, Boston, September 25, 1919, Vol. 181, No. 13, p. 379. Abst.: *Journal A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1160.

CONTRACTURE, DUPUYTREN'S, Description of Operation,—Gill, A. B.; *Annals of Surgery*, Philadelphia, August, 1919, Vol. 70, No. 2, p. 221.

CONTRACTURES, War,—Abst.: *Medical Journal of Australia*, August 30, 1919, Vol. 2, No. 9, p. 178.

CURATIVE THERAPY, Application of, in the Ward,—Marble, H. Chase; *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, p. 787.

ELBOWS, Flail, Appliance for,—Chambers, F. M.; *Military Surgeon*, Vol. 45, No. 4, October, 1919, pp. 440-445.

EXTREMITIES, Enchondromas, Multiple,—Ludlon, A. I.; *China Medical Journal, Shanghai*, July, 1919, Vol. 33, No. 4, p. 323.

FEMUR, Fractures of,—Driberg, J.; Lancet, London, August, 1919, Vol. 2, No. 5008, p. 311.

FEMUR, Open Operation Upon the Shaft, Allen Stretcher in, and in Fracture of the Pelvis,—Newell, Edw. T.; *International Journal Surgery*, September, 1919, Vol. 32, No. 9, p. 287.

FINGERS, CLUBBED,—Weber, F. P.; *British Medical Journal*, September 20, 1919, No. 3064, p. 379.

FLAT FEET,—Powell, W. L.; *Virginia Medical Monthly*, Richmond, September, 1919, Vol. 46, No. 6, p. 131.

FLAT FEET,—Smith, H.; *British Medical Journal*, London, September 6, 1919, Vol. 2, No. 3062, p. 343.

FOOT, TRENCH,—Mercier, R.; *Bulletin de l'Academie de Medecine*, Paris, July 22. 1919, Vol. 82, No. 28, p. 80.

FRACTURE, Acetabulum with Intrapelvic Displacement of Femoral Head—Peet, M. M.; *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 296.

FRACTURES, CLAVICLE, Barrel Stave Splint in,—Royster, H. A.; *Annals of Surgery, Philadelphia*, October, 1919, Vol. 70, No. 4, p. 474.

FRACTURE CLAVICLE, A New Dressing For,—Legrand, A.; *Journal de Medecine de Paris*, May, 1919. Abst.: *New York Medical Journal*, September 20, 1919, Vol. 60, No. 12, p. 519.

FRACTURE, COMPOUND, Reconstruction of Bone and Primary With,—Nordentoft, J.; *Hospitalstidende, Copenhagen*, August 13, 1919, Vol. 62, No. 33, p. 945. Abst.: *Journal A. M. A.*, October 4, 1919, Vol. 73, No. 14, p. 1098.

FRACTURES, Compound, Treatment of,—Orr, H. Winnett; *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, p. 787.

FRACTURES, Compound, War Lesson,—Miller, J. A.; *New York Medical Journal*, September 13, 1919, Vol. 110, No. 11, p. 460.

FRACTURES, DEFORMITY in, Correction of; Mechanism of Fractures of Upper Extremity,—Thomas, T. T.; *Annals of Surgery, Philadelphia*, September, 1919, Vol. 70, No. 3, p. 359. Abst.: *Journal A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1160.

FRACTURES OF THE FEMUR—Aguilar, F. C.; *Archivos Espanoles de Pediatria*, Madrid, June, 1919, Vol. 3, No. 6, p. 321. Abst.: *Journal A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1168.

FRACTURES, FEMUR, Lower Third—Van de Velde, Joseph; *Annals of Surgery*, Philadelphia, October, 1919, Vol. 70, No. 4, p. 461.

FRACTURES, Gunshot,—Wilson, G. E.; *Medical Record, New York*, August 30, 1919, Vol. 96, No. 9, p. 365.

FRACTURES, Gunshot, Treatment of,—Blake, J. A.; *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, pp. 748-9.

FRACTURES, HUMERUS, Dislocation of Head,—Painter, C. F.; *Annals of Surgery*, Philadelphia, August, 1919, Vol. 70, No. 2, p. 469.

FRACTURES, HUMERUS, Gunshot,—Smith, M. K.; *Annals of Surgery*, Philadelphia, October, 1919, Vol. 70, No. 4, p. 430.

FRACTURES LAMINA; Laminectomy,—Smith, R. E.; *Practitioner*, London, September, 1919, Vol. 103, No. 3, p. 229.

FRACTURES, Long Bones, Repair by Autogenous Bone Grafting—Martin, F., *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 305.

FRACTURES, LONG BONE, Treatment of,—Smith, W. F.; *Arkansas Medical Society Journal*, Little Rock, August, 1919, Vol. 16, No. 3, p. 65.

FRACTURES, MECHANISM of, Upper Extremity; Deformity in,—Thomas, T. T.; *Annals of Surgery*, Philadelphia, Septemher, 1919, Vol. 70, No. 31, p. 350. Abst.: *Journal A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1160.

FRACTURE, Neck of Femur, Ambulatory Treatment of;—Bradford, E. H.; *Journal of Orthopaedic Surgery*, August, 1919, Vol. 1, No. 8, pp. 465-8.

FRACTURES, NON UNION, BONE GRAFTING, for,—Sanderson, E. L.; *New Orleans Medical and Surgical Journal*, September, 1919, Vol. 72, No. 3, p. 130.

FRACTURES, Overlapping, Application of Extension to, Without open Operation,—Freeman, L.; *Annals of Surgery*, Philadelphia, August, 1919, Vol. 70, No. 2, p. 231.

FRACTURE, PELVIS, Use the Allen Stretcher in,—Newell, E. T.; *International Journal Surgery*, September, 1919, Vol. 32, No. 9, p. 287.

FRACTURES, Radius, Head of,—Duagherty, L. E.; *Minnesota Medicine*, St. Paul, September, 1919, Vol. 2, No. 9, p. 350.

FRACTURES, Treatment of: War Lessons,—Groves, E. W. H.; *Journal A. M. A.*, September, 1919, Vol. 73, No. 10, pp. 742-748.

FRACTURES, War Statistical Summary of,—Walker, J. B.; *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, p. 750.

GRAFTING BONE, Repair by Autogenous, in Fractures of Long Bones,—Martin, F.; *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 305.

GUNSHOT WOUNDS, Deaths and Disabilities,—Wilson, J. A.; *Glasgow Medical Journal*, September, 1919, Vol. 42, No. 9, p. 119.

HALLUX VALGUS, Treatment of,—Juvara, E.; *Presse Medicale*, Paris, July 17, 1919, Vol. 27, No. 40, p. 395. Abst.: *Journal A. M. A.*, September 13, 1919, Vol. 73, No. 11, p. 870.

HIP, PARALYZED, Correction of,—van Assen.; *Nederlandsch Tijidschrift v. Geneeskunde*, Amsterdam, July 5, 1919, Vol. 2, No. 1, p. 27. Abst.: *Journal A. M. A.*, October 4, 1919, Vol. 73, No. 14, p. 1097.

HIP, Pseudarthrosis of the,—De Laborie, B.; *Paris Medical*, July 19, 1919, Vol. 9, No. 29, p. 57. Abst.: *Journal A. M. A.*, September 13, 1919. Vol. 73, No. 11, p. 870.

JAW, Vestibular, Reflex,—Mygind, S. H.; *Ugeskrift for Laeger*, Copenhagen, July 24, 1919, Vol. 81, No. 30, p. 1205. Abst.: *Journal A. M. A.*, September 13, 1919, Vol. 73, No. 11, p. 874.

JOINTS, Fractures and wounds of, Treatment of,—Brechot; *Archives de Medecine et de Parrm Militaires*, Paris, January, 1919, Vol. 71, No. 1, p. 43.

JOINTS, Hemophilic,—Escande and Tapie; *Journal de Radiologie*, Paris, August, 1919, Vol. 3, No. 7, p. 298. Abst.: *Journal A. M. A.*, September 27, 1919, Vol. 73, No. 13, p. 1017.

JOINTS, Shoulder, Loose Osteo-Cartilaginous Bodies in,—Henderson, M. S.; *American Journal Orthopaedic Surgery*, December, 1918. Abst.: *Journal of Australia*, August 30, 1919, Vol. 2, No. 9, p. 178.

KNEE JOINT, Gunshot Injuries of,—David, V. C.; *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 290.

KNEE JOINT, Surgery of, Contribution of War to,—Lee, B. J.; *Annals of Surgery*, Philadelphia, October, 1919, Vol. 70, No. 4, p. 464.

KNEE JOINT WAR INJURIES; Willems' Treatment,—McWilliams and Hetzel; *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 257. Abst.: *Journal A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1160.

KNEE JOINT WOUNDS, Treatment of,—Pool and Jopson, *Annals of Surgery*, Philadelphia, September, 1919, Vol. 70, No. 3, p. 266. Abst.: *Journal A. M. A.*, October, 11, 1919, Vol. 73, No. 15, p. 1160.

LANE'S PLATES With Fractures,—Swett, P. P.; *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, p. 787.

LIMBLESS MEN, Treatment and Training of,—Lynn, Thomas, Sir J.; *Lancet*, April 19, 1919. Abst.: *International Journal Surgery*, September, 1919, Vol. 32, No. 9, 288.

LOOP Operation for Equino Valgus,—Whitman, R.; *Journal Orthopaedic Surgery*, August, 1919, Vol. 1, No. 8, pp. 459-464.

LUMBAR PUNCTURE, Causation of Meningitis,—Wegeforth, P., and Latham, J. R.; *American Journal Medical Science*, August, 1919. Abst.: *New York Medical Journal*, September. 20, 1919, Vol. 60, No. 12, p. 519.

NERVE ANASTOMOSIS, Clinical Study of,—Adson, A. W.; *Annals of Surgery*, Philadelphia, August, 1919, Vol. 70, No. 2, p. 157.

NERVES, GUNSHOT INJURIES of, Operative Findings in,—Morton, C. A.; *Bristol Medico-Chirurgical Journal*, Summer, 1919, Vol. 36, No. 136, p. 55.

NERVE, MUSCULOSPIRAL, Gunshot Injury of,—Reder, F.; *Annals of Surgery*, Philadelphia, August, 1919, Vol. 70, No. 2, p. 226.

NERVE SUTURE, Results of,—Dane, P. G.; *Medical Journal Australia*, Sydney, July 26, 1919, Vol. 2, No. 4.

ORTHOPAEDIC SERVICE IN BRITISH GENERAL HOSPITALS—Osgood, R. B.; *Military Surgeon*, Washington, D. C., September, 1919, Vol. 45, No. 3, p. 262.

ORTHOPEDIC SURGERY, Physical Treatment in Relation to,—Bristow, W. R.; *Lancet*, April 19, 1919. Abst.: *International Journal Surgery*, September, 1919, Vol. 32, No. 9, p. 287.

ORTHOPEDIC SURGERY, Practice and Training of—Stiles, Sir Harold; *Lancet*, April 19, 1919. Abst.: *International Journal Surgery*, September, 1919, Vol. 32, No. 9, p. 287.

OSTEOCHONDRITIS of the Hip,—Roberts, P. W.; *Journal Orthopaedic Surgery*, August, 1919, Vol. 1, No. 8, p. 493-6.

OSTEOMYELITIS, Chronic, Treatment of—Eikenbary, C. F.; *Journal Orthopaedic Surgery*, February, 1919. Abst.: *Medical Journal Australia*, August 30, 1919, Vol. 2, No. 9, p. 178.

PARALYSIS, Peripheral, of the Fifth Nerve,—Pennato, P.; *Rivista Critica de Clinica Medica*, Florence, May 17, 1919, Vol. 20, No. 20, p. 229. Abst.: *Journal A. M. A.*, September 13, 1919, Vol. 73, No. 11, p. 872.

PARAYLSIS, RADIAL, Plastic Operation to Correct,—Henningsen, E.; *Hospitalstidende*, Copenhagen, July 23, 1919, Vol. 62, No. 30, p. 881. Abst.: *Journal A. M. A.*, September 27, 1919, Vol. 73, No. 13, p. 1022.

PARALYSIS, Spastic in Children,—Grossman, J.; *Medical Record*, New York, Vol. 96 (1919), No. 11, p. 453.

PARALYSIS, Spastic, Operative Treatment of,—Ansart, M. B.; *Archives Espanolis de Pediatria*, Madrid, April, 1919, Vol. 3, No. 4, p. 202. Abst.: *Journal A. M. A.*, September 6, 1919, Vol. 73, No. 10, p. 800.

PELVIC PRESENTATIONS,—Fox, M. R.; *Colorado Medicine*, Denver, September, 1919, Vol. 16, No. 9, p. 226.

POLIOMYELITIS, Acute,—Gannata, S.; *Pediatria, Naples*, August, 1919, Vol. 27, No. 8, p. 465. Abst.: *Journal A. M. A.*, Oct. 4, 1919, Vol. 73, No. 14, p. 1095.

POLIOMYELITIS, Acute, in Granada,—Reta, B.; *Medicina Ibera*, Madrid, June 21, 1919, Vol. 7, No. 85, p. 224. Abst.: *Journal A. M. A.*, Oct. 4, 1919, Vol. 73, No. 14, p. 1097.

POLIOMYELITIS, Second Attack,—Francis, F. D., and Moncreiff; *Journal of Nervous and Mental Diseases*, April, 1919. Abst.: *New York Medical Journal;* September 20, 1919, Vol. 60, No. 12, p. 519.

POSTOPERATIVE CARE OF SURGICAL PATIENTS,—Brown, A. J.; *Nebraska State Medical Journal*, Norfolk, July, 1919, Vol. 4, No. 7. p. 197.

POTT'S DISEASE, Modern Treatment of,—Calot, F.; *Le Monde Medical*, March, 1919. Abst.: *Medical Journal Australia*, August 30, 1919, Vol. 2, No. 9, p. 178.

PSEUDARTHROSIS, Treatment of,—Tange, R. A.; *Nederlandsch Tijidschrift v. Geneeskunde, Amsterdam*, July 12, 1919, Vol. 2, No. 2, p. 91.

RACHITIS and OSTEOMALACIA,—Looser, E.; *Correspondenz-Blatt fur Schweizer Aerzte*, Basel, July 17, 1919, Vol. 49, No. 29, p. 1065. Abst.: *Journal A. M. A.*, Oct. 4, 1919, Vol. 73, No. 14, p. 1095.

RECONSTRUCTION, Physical, of Disabled Soldiers,—Billings, Frank; *New York State Medical Journal*, August, 1919, Vol. 19, No. 8. Abst.: *Journal Orthopaedic Surgery*, October, 1919, Vol. 1, No. 10, p. 639.

RECONSTRUCTIVE SURGERY,—Elmslie, R. C.; *Lancet*, April 19, 1919. Abst.: *International Journal Surgery*, Vol. 32, No. 9, p. 287.

STIFF KNEE, Treatment of, In Relation to Compound Fractures of the Femur, —Alexander, C. B.; *British Medical Journal, London*, September 6, 1919, Vol. 2, No. 3062, p. 339.

SURGERY, WAR, PHASES OF,—Powers, C. A.; *Annals of Surgery*, Philadelphia, October, 1919, Vol. 70, No. 4, p. 476.

SURGICAL PROBLEMS, PRESENT, In U. S. Army Hospitals,—Orr, H. W.; *Military Surgeon*, August, 1919, Vol. 45, No. 2, p. 176.

TENDON TRANSPLANTATION FOR DORSAL INTOROSSEOUS PARALYSIS, —Teece, L. G.; *Medical Journal of Australia*, Sydney, August 9, 1919, Vol. 2, No. 6, p. 131.

TENDON TRANSPLANTATION, in Radial Paralysis,—Jarkowski and Achard; *Revue Neurologique*, Paris, April, 1919, Vol. 26, No. 4, p. 283. Abst.: *Journal A. M. A.*, October 11, 1919, Vol. 73, No. 15, p. 1166.

TETANUS,—Dorsey, T. A.; *Nebraska State Medical Journal*, Norfolk, July, 1919, Vol. 4, No. 7, p. 218.

U. S. ARMY HOSPITALS, Present Surgical Problems in,—Orr, H. W.; *Military Surgeon*, Washington, D. C., August, 1919, Vol. 45, No. 2, p. 176.

Current Orthopaedic Literature

Gunshot Fractures. By George E. Wilson, M. B., Toronto; *Medical Record*, Aug. 30, 1919

The amount of damage which a missile is capable of doing depends on its weight, velocity, size and shape. Hence the difference in wounds caused by rifle and machine gun bullets, shell fragments and shrapnel. As a rule, the denser the tissue, the greater the amount of damage.

In the recent war it was soon established that if a wound were treated within a few hours of its infliction and thoroughly excised, it could be sutured with safety. It is estimated that considerably over 50 per cent of the wounds can be treated by excision and closure. Excision was done extensively in 1915, but it was not until the last year of the war that compound fractures were commonly treated by excision and primary or delayed primary suture.

The requisites for the success of this treatment are first, too much skin must not have been shot away; second, the technique must be perfect, and third, there must not be signs of well established inflammation. Excision should be done within twelve hours after the receipt of the wound, if possible. Many cases were successful after 24 hours had elapsed. The earlier the better, provided the patient is not too shocked to stand the necessary procedure.

Technique: The patient having had an immunizing dose of antitetanic serum, is anesthetized, preferably by warmed ether. The patient's clothes are removed after anesthetization so that the shock is as little as possible. The surrounding area is then thoroughly cleansed, while the wound is protected with gauze. Any foreign bodies are now removed from the wound. With fresh gloves and gown the surgeon then excises the wound using mouse-toothed forceps and a very sharp scalpel. It is important that the knife does not enter the wounded area during the dissection. All loose splinters of bone are removed. Next, all bleeding is stopped. When this cannot be done the wound is not sutured, but packed with gauze and sutured in 24 or 48 hours (delayed primary suture.) In suturing it is important to leave no dead spaces in which serum will collect. The area can be closed by catgut in layers or by silkworm-gut. Dressings and bandages are then applied and the limb is carefully splinted. Complete rest is most important. In severe wounds without fracture, splinting is also necessary.

The author then considers some of the more important gunshot fractures in detail, beginning with those of the skull.

Gunshot wounds of the spine have a higher mortality than those in any other region in the body. The symptoms are those generally met with in the fracture dislocation of civil life. In the early stage of these wounds much of the paralysis in many of the cases is due to traumatic edema and circulatory disturbances. As in the case of wounds in general, excision should be practised. The cord should not be operated on unless there are evidences of de-

pressed bone within the canal or the patient suffers very severe pain. Early operation is the best. In late operation there is danger of infection as a complication.

In gunshot wounds of the femur the fracture besides being comminuted, is generally oblique. It is important to apply a splint at the earliest possible moment to prevent shock. For transportation purposes the Thomas splint is the best. At the operation, cultures are made from various parts of the wound. In the cases of primary closure if the wound shows Streptococcus Haemolyticus, the wound should be opened and drained at once. If there is any doubt as to the sterility of a wound, delayed primary suture is resorted to. The indications for a primary amputation are : (1) Great pulverization of the bone. (2) Extensive loss of skin. (3) Rupture of the main blood vessels. (4) The establishment of virulent sepsis in extensive wounds, the patient being in a low condition. (5) Fracture complicated by extensive comminution of the condyles. (6) The presence of well established gas gangrene.

The balance of the article is devoted to a discussion of gunshot fractures involving the knee joint, hip joint, leg, foot, pelvis, upper extremity, mandible, ribs and scapula.—*Mark Cohn, New York.*

Pseudarthrosis of the Humerus Consecutive to War Wounds. By Dr. Charles Dujarier; *Medical Record*, August 23, 1919.

The author's observations are based on thirty-eight operations, in as many cases, performed by him while chief of a surgical unit in France. Thirty-six cases were due to comminuted fracture produced by projectiles. Two cases were so called closed pseudarthroses, caused by the interposition of muscular tissue between the fragments. In these two cases the interposed tissue was raised, the fragments were held in position by a screw plate, and healing was without incident. In the other cases, some showed considerable loss of bony substance with wide separation of the fragments, while in others suppuration was the predominating feature and the separation between the two fragments was slight.

Radiographs show osteoporosis of variable extent, sequestra either superficial or central, and often the projectiles. When the fragments have united, the bone again becomes opaque in proportion as it resumes its proper function.

The adjacent articulations are often stiffened. The muscles are always injured. The brachial artery was not injured in any of the cases. In none of the cases was there serious injury to the ulnar or median nerves. The radial nerve was found divided in seven cases.

The author at first used to wait one or two months after the closure of fistulae before operating; but after observing that whatever the interval, one was never sure of having postoperative asepsis, he did not consider this delay necessary. He generally drained the incisions. The good results that he obtained led him to operate in fistulous cases, and in those cases where he drained freely, obtained very pleasing results. He believes that the use of the full sized

bone graft having the purpose of restoring the humerus to its proper length is very rarely indicated. He has not used it in his cases. In several of his cases there was over 10 cm. shortening in the arm without any functional trouble. Also the possibility of fracture of the graft makes the prognosis doubtful.

Plating was used in sixteen cases, in eight of which there was union. In five there was failure or only improvement, and the remaining three cases are still under treatment. Silver wire suture was used in nine cases with seven unions, one failure and one case still under treatment. Clamps were used in two cases and union was obtained in both. Osteoperiosteal grafts after the method of Delageniere, were used in ten cases where the fragments were in apposition, without a flail-like pseudarthrosis. In these cases there were eight unions and two failures. Of the thirty-eight cases, twenty followed an aseptic course.

The radial nerve, when it has not been injured, should be avoided during the operation. In five of the cases where the nerve was wounded before operation, it was sutured. In two of these cases bony union and regeneration of the nerve was obtained.

After the operation, the limb is immobilized with the arm parallel to the body and the forearm along the anterior surface of the thorax in such a way as to leave the wound exposed, thus permitting dressing of the wound without affecting the immobilization.

Omitting the cases still under treatment, the author obtained union in 25 of 33 cases (75.7 per cent.). The time required for union was as follows: 1 month, 3 cases; 2 months, 12 cases; 3 months, 2 cases; 4 months, 3 cases; 5 months, 1 case; 7 months, 1 case; 10 months, 1 case; 11 months, 1 case; 1 year, 1 case.—*Mark Cohn, New York.*

Growth of the Surgery of the Front in France. By Sir Anthony Bowlby. *British Medical Journal*, August 2, 1919.

The author, who was consulting surgeon to the British armies in France throughout the course of the war, describes the development of the work of the British Medical Service from the time of the first battle of Ypres in October, 1914, to November 11, 1918. At the former date there were only three casualty clearing stations near this front, intended to be used only for evacuation. Each had seven medical officers and 200 stretchers; there were no beds. The end of 1914 found the C. C. S. with a small number of beds and nurses, and they were allowed to operate on and retain wounded men.

In 1915 there was regular operating in the C. C. S., surgical staffs were trained, accommodations for patients increased, and equipment added to. They (C. C. S.) accomplished all that was surgically necessary in times of calm, but were always overwhelmed when there was a great battle. An advanced operating center, in front of the existing C. C. S., was used for the first time at the battle of Loos in September, 1915. It and the C. C. S. were swamped by the number of cases brought in. In 1915 there were nearly 200,000 wounded, and

of these about 50,000 were wounded at Loos. At the end of 1915 the C. C. S. were real front line hospitals and the policy of providing the wounded with prompt surgical treatment was firmly established.

In 1916 front line surgery made a very great advance. In the Somme region there were 14 C. C. S., each for not less than 1,000 patients, and an advanced operating center for abdominal cases was provided. There was an increase in the staff of surgeons and nurses before heavy fighting began. As a result of the increased staff, 30,000 essential operations under anaesthesia were performed at the front during a period of three and one-half months

In 1917 the surgery everywhere was much more efficient, resuscitation wards and arrangements for badly shocked men were in every C. C. S. The Thomas splint was now being used by all the C. C. S. and field ambulances and as far front as the regimental aid posts in some areas. The methods of applying it and other first aid splints had been thoroughly taught in every field ambulance and C. C. S. on the whole front. Many new C. C. S. were provided before the battles of Vimy and Arras began and the surgeons were reinforced by teams from other units, each team composed of a surgeon, a nurse and an anaesthetist. In making arrangements for the third battle of Ypres, each C. C. S. had at least 24 medical officers. Each C. C. S. kept eight operating tables at work and 60,000 wounded were treated under anaesthetics during the fight. It was at this time that blood transfusion was first done on a large scale. Almost all the necessary operations were done at the front on this occasion.

In 1918 the medical service was fully prepared for the German attack which began on March 21st. Although some of the C. C. S. had to retire, the front line surgery continued without much interruption. The British advance which began on August 8th, and which was practically never stopped until the armistice was signed, found the C. C. S. ready in every way and ample reinforcements of surgical teams arrived in plenty of time. The lack of proper transportation facilities was a great difficulty. From August 8th to November 11th there were more than 300,000 wounded to deal with. The advances meant a constant moving of the C. C. S., and it was often necessary to send some patients to the base before operation or evacuate others sooner than surgically advisable because of the constantly recurring calls to move.

From the author's description of the growth of the work and the way in which the treatment of large numbers of wounded was adjusted to circumstances incidental to modern warfare, it can readily be appreciated that the British surgery of the front showed a continuous improvement in each successive year of the great war.—*Mark Cohn, New York.*

Fractures Complicating the Ankle-Joint. Stoner, A. P. *Journal Iowa Medical Society*, 1919, ix, 148. *Surg., Gyn. and Obst.*, Vol. XXIX, September, 1919. No. 3.

Points about Pott's fracture to bear in mind:

1. Pott's fracture is always an eversion and abduction fracture.

2. The fibula is always fractured and usually within 1½ inches of the point.

3. The tibiofibular and interosseus ligaments are always ruptured, permitting more or less separation of the lower fragments of the fibula from the tibia.

4. For proper healing in Pott's fracture the foot should be placed in the most exaggerated adducted and inverted position and maintained in this posture until healing is complete.

5. An inversion fracture is never a Pott's fracture and should be put up in the reverse position, abduction and eversion.

6. The joint should not be exercised until after a period of 8 weeks, and no weight should be borne on the foot for three or four weeks longer.—*Leo C. Donnelly, Detroit.*

THE FUTILITY OF BRIDGING NERVE DEFECTS BY MEANS OF NERVE FLAPS. By Byron Stookey, A. M., M. D., Maj., A. M. C. *Surg., Gyn. and Obst.*, Vol. XXIX, September, 1919, No. 3.

1. The repair of nerve defects by means of nerve flaps has not been definitely supported clinically, as evidenced by a critical study of the reported cases.

2. Experimentally it has been shown that nerve flaps do not serve as conducting paths for the downgrowing neuraxes.

3. Nerve flaps whether central or peripheral are merely degenerated partial nerve segments. Continuity and union of neuraxes does not take place at point of suture.

4. To avoid fallacious deductions it is important to distinguish between the level of the injury to the nerve trunk and the level at which muscular branches arise.

5. Abnormal communicating branches are not rare, particularly between the median and ulnar. Such anomalies must be taken into consideration in any careful study of nerve injuries.

6. Judging from the level of the lesions, muscles may not be presumed paralyzed but should be demonstrated paralyzed.

7. Total movements may not be offered as evidence of return of function. The action of individual muscles must be given.

8. Reports of peripheral nerve injuries, to be of value, must be accompanied by motor, sensory and electrical findings.

9. By the formation of nerve flaps from the central stump a portion of the nerve from which neuraxes must grow is removed. Distal as well as central flaps may sever muscular branches. By reversing the flaps they are taken out of their field. Thus, the downgoing neuraxes are prevented from reaching

the muscles through these muscular branches, even were regeneration to take place.

10. The nerve flap method to bridge nerve defects should be discarded in peripheral nerve surgery.—*Leo C. Donnelly, Detroit.*

Dupuytren's Contracture With a Description of a Method of Operation. By A. Bruce Gill. *Annals of Surgery*, 1919, LXX, 221.

The treatment of Dupuytren's contracture has long been tedious and often unsuccessful. The author has employed the following method of operation: a transverse incision is made along the distal palmar crease, through which incision alone a careful dissection is made of the entire palmar fascia as far towards the base of the palm as is necessary and to the web of the fingers. Within these limits the entire fascia can be exposed, freed, and excised without injury to the underlying tendons, vessels, and nerves. The tendons are not lengthened because they are not contracted. If now the proximal interphalangeal joint cannot be easily extended, the head of the first phalanx must be excised. A small free fat transplant from the thigh is next inserted smoothly beneath the palmar skin without sutures. A well padded splint is used for a week.

Dupuytren's contracture is a contracture of the palmar fascia alone, there is thickening of the digital processes of the palmar fascia primarily, and of the main body of the fascia secondarily. Two theories are advanced as to etiology: either the contracture is due to external agencies as injuries or oft-repeated stresses to the palm, or it is constitutional in origin with palmar irritation as an exciting cause.

The advantages of an incision along a transverse crease of the palm are: the smaller scar or keloid overgrowth, and the smaller resulting contraction that would follow an incision transverse to the crease.

Unfortunately only one case is cited, and that of recent operation.—*Robert G. Packard, Denver.*

The Application of Extension to Overlapping Fractures, Especially of the Tibia, by Means of Bone Screws and a Turnbuckle, Without Open Operation. By Leonard Freeman. *Annals of Surgery*, 1919, LXX, 231.

Freeman gives his procedure in tibial fractures requiring prolonged extension, not satisfactorily obtained by ordinary means. When a weight and pulley cannot be used because of lack of sufficient skin surface, when a shoe or glued stocking impedes the circulation, and when a Steinman pin through or above the os calcis puts too much strain on the ankle joint, and since an open operation is at best not favorable, the author advises the use of the external bone clamp.

The instruments include two (or four) strong steel bone-screws, a drill of smaller diameter than the screws, a turnbuckle, and a long clamp for holding the screws in position after adjustment of the fragments. Under general anaesthesia, and after rough manual adjustment of the fragments, a small buttonhole incision is made over the tibia on either side of the fracture, the drill is insinuated through the entire diameter of the bone, the screws are then fixed, the turnbuckle placed between them close to the skin, and proper extension applied, and finally the clamp is placed upon the screws as low as practical, the turnbuckle removed and dressings applied. This apparatus may be left in place for a number of weeks, the wounds being as frequently dressed as indicated. Finally the entire apparatus may be removed without anaesthesia, and some splint applied.

The advantages of this treatment include: the large amount of force possible, very little discomfort, small amount of foreign material in the bone, facility of application and removal, absence of joint strain, and comparative freedom of patient.

Plates showing the apparatus are given, also some X-rays of fractures showing the apparatus applied.—*Robert G. Packard, Denver.*

Pseudoarthroses of the Long Bones Following Gun-Shot Fracture. By Glueke. *Archiv fur Orthopadische und Unfall-Chirurgie*, December, 1918, Vol. 16, No.2.

The questions of the etiology and pathology of the pseudarthroses as well as the treatments are most exhaustively discussed in this rather extensive paper and a number of X-ray pictures are furnished illustrating important points of the treatment. The X-ray does not always allow strict division between retarded callus formation and pseudarthroses except in cases where there is a gross defect in the continuity and in those showing signs of retrograde changes of the bone.

The occurrence of pseudarthroses is easily explained where both bones are destroyed for a considerable distance, directly from injury, or in those instances where too extensive a debridement has been carried out. The author very properly warns against a too radical debridement of bone, as has been the custom earlier in the war. Furthermore, excessive extension also is often responsible for the occurrence of a pseudarthrosis, as well as too early use of the affected limb. The author points out that the usually allotted time of six to eight weeks is by no means sufficient for the establishment of a solid, reliable callus. The question of systemic conditions or dyerasias does not come much into consideration in military surgery.

The locality of the fracture, however, is of great importance. Especially is this true of the long bones where the fracture occurs near the joint end. Callus production here is so inferior that it considerably interferes with consolidation.

Clinically the significance of pseudarthrosis differs very much with the bone affected. When situated in the long bones of the extremities the function is

invariably greatly interfered with, if not absolutely abolished. This is true especially of the femur, and to a lesser degree of the humerus.

In the leg and forearm pseudarthrosis in one of the bones naturally causes less severe functional disturbances. A pseudarthrosis in the lower third of the fibula may cause considerable valgus deformity; pseudarthrosis in the upper third of the radius will give little trouble; but when situated in the lower third it will interfere greatly with flexion and extension and pro and supination of the hand. From this it will appear that the significance of pseudarthrosis must be judged largely from the location and will vary naturally in different individual cases.

Treatment: The author does not consider the treatment with prostheses or splints a satisfactory one. Neither do the older, more or less conservative methods give much satisfaction. Such methods are injection of blood, the percussing and damming method, friction of the fragments, etc. The so called simple operative measures consisting in refreshing of the bone ends, are likewise unreliable.

There are only two operative methods which, the author feels, deserve consideration.

1. The direct union of the bone ends after refreshing sufficiently to eliminate all eburnated bone. This is only possible where the defect in the bone is not too great and in single bone regions, such as the humerus and femur. Fixation can then be secured by wire or better by Lane plates, for which latter the author has great regard.

In the forearm and leg the author warns explicitly of the shortening of the sound bone in order to accomplish adaptation of the affected bone. He has in several cases seen pseudarthroses develop in the sound bone following operative shortening.

A gap in the continuity of the bone should always be taken care of by bone transplants. These may be pedicled flaps, as in the method of Brandes, Moszkovicz and others, but the author prefers the free bone plasty to the pedicled flap. The periosteum should always be taken along. The intra medullary transplant is also very useful although the author has some doubt as to a sufficient amount of bone being reprodnced from the bone marrow, when the latter technic is used. One of the main points is that a broad bone contact must be created between the transplant and host in order to insure vigorous callus formation.

As far as infections are concerned the success of the bone plasty greatly depends upon an aseptic course. Nevertheless, some cases show good results even in the presence of slight infections.

The experience of the author is based upon 51 operations for pseudarthroses in the long bones of the extremity of which 49 cases are considered concluded and ready for report. There was no serious complication in any of the cases and no deaths.

Operations on the lower extremities include 3 cases of pseudarthrosis of the femur; of the upper extremities, 14 cases of the humerus; and of the forearm, 34 cases, of which 16 involved the ulna, 15 the radius and in 3 cases both bones were operated.

Of the 49 cases ready for report, 8 were failures. Of these 8 cases 5 failures must be attributed to faulty technic, an avoidable factor.

In general, the author feels that the results after operation for pseudarthroses following gun-shot fracture, are very satisfactory provided the operative method is carefully selected and the proper technic prevails.—*Arthur Steindler, M. D., Iowa City, Ia.*

The Surgical Treatment of Hallux Valgus and Its Complications. By Jos. E. Fuld, M. D. *American Medicine*, August, 1919.

The surgical treatment of hallux valgus should take into consideration not only the correction of the deformity, but the preservation of the weight-bearing function of the foot and the prevention of recurrence.

Resection of the head of the first metatarsal seriously weakens the longitudinal arch and therefore impairs the weight bearing function of the foot. The author considers that this is rarely necessary. He chisels off the hypertrophied bony projection on the inner side of the head of the metatarsal with the periosteum covering it. The capsule is replaced to cover the raw surface of the bone and fixed with catgut sutures. After this comes the essential part of the operation which the author has devised to prevent recurrence of the deformity. The tendon of the Abductor Hallucis is transplanted from its insertion on the inner side of the base of the first phalanx of the great toe to the middle of the inner surface of the first phalanx and sutured with fine silk or Pagenstecher thread to the periosteum. The author gives in detail the various steps of the operation that he advocates.—*Mark Cohn, M. D., New York.*

The Work of Physical Reconstruction as It Concerns Orthopedic Surgery. By Joel E. Goldthwait, M. D., *New York Medical Journal*, September 6, 1919.

Dr. Goldthwait who was senior consultant in the division of Orthopedic Surgery of the A. E. F., gives his observations on the part played by the Orthopedic Surgeon in the treatment of casualties resulting from the war, and also on the manner in which men who were entirely unequal to the strain of full war activity were developed in special training organizations and either sent back to the combat line or placed in non-combatant work.

In treatment the Orthopedic view was kept foremost from the beginning. The important question was, "What can the man do after treatment has been completed?"

The responsibility for the supervision of the large number of casualties in which prolonged treatment was necessary was assigned in the American army to the division of Orthopedic Surgery. The closest co-operation possible existed between the orthopedic surgeon, the general surgeon, and the internist.

It was found best to bring the reconstruction work right up to the trenches, so that proper splinting of wounded parts could be done before the man was

moved. This lessened the shock of transportation and prevented laceration of tissues and other damage from bone fragments. In order to simplify the treatment, eight types of splints were selected by a special medical board. Stretcher bearers, ambulance corps men, and medical officers were drilled so that the splints were applied in the most efficient manner and with the greatest possible speed. Thus many lives were saved. In over 200,000 battle casualties in the entire A. E. F. there were less than 4,000 cases of amputation.

There was a careful standardization of the positions in which fractures of different types were to be put up and the kind of splints used. This made it possible to transport large numbers of patients with serious injuries from one hospital to another without harm.

The treatment was not only planned with reference to the perfect position of bones, but the damaged part was used as early as possible in the wards or in curative work-shops. This not only caused more rapid healing, but a more perfect functional condition as the end result.

A large number of American soldiers in France were incapable of sustained normal physical effort because of weak feet, weak backs and poorly poised bodies. With these men the problem was wholly one of training, and they were sent to special training organizations. Squad drill, bayonet drill, marching, etc., were used. The periods of work were shorter than usual and there were intervals for rest and play.

Normal posture was insisted on. In a certain number of patients with extreme degrees of flat-foot the inner edges of the heels were raised or a figure of eight ankle strap was used, with great success. Foot plates were not used in the A. E. F. Men who could be made of full combat fitness, which required in some cases three or four months, were sent back to the combat line. The others were utilized for non-combat service.

After July 1st, 1918, when combat activities increased rapidly, it was not possible to keep the men for three or four months to bring them to full military fitness. When this could be done in four or five weeks the men were returned to the combat line. The others were given short periods of training, properly shod, and given instructions that would help them so that they would have the minimum of disability and were assigned to non-combatant work.—*Mark Cohn, M. D., New York.*

Spastic Paralysis in Children. By Jacob Grossman. *Medical Record*, September 13, 1919.

The author describes the etiology, clinical course and treatment of eight cases that have come under his observation.

One of the patients, a boy of seven years, had a syphilitic spastic paraplegia. The father had a spastic paraplegia with a 4 plus Wassermann. The mother had cerebro spinal syphilis with 4 plus Wassermann, three miscarriages, and four living children all of whom had 4 plus Wassermann. The spastic paraplegia began at the age of four years.

From his experience the following conclusions are reached by the author:

1. Spastic paralysis may result from an apparently normal delivery.

2. Infants who apparently recover may develop a spastic hemiplegia at a later period. A guarded prognosis should be given in all cases.

3. In a number of cases the only clue to a cerebral injury is the presence of stiffness, which mothers notice while bathing and dressing the children.

4. In other cases delayed function of sitting and walking direct one to the existing spastic condition.

5. Convulsions in infants either immediately or shortly after birth should make us suspect cerebral injury.

6. The possibility of syphilis as an etiologic factor should always be borne in mind.

7. Massage, electricity, supports, tenotomies, and muscle education usually offer relief and influence to a certain degree the existing condition.—*Mark Cohn, M. D., New York.*

National Organization of Rehabilitation of the Disabled in Italy. By Prof. V. Putti, Bologna, Italy. *Medical Record*, September 27, 1919

Dr. Putti gives a detailed account of the plans and development of this work in Italy from the beginning of 1915.

At the end of physical and orthopedic treatment, the disabled man remains in the school for vocational training. Re-education is not compulsory in Italy, but the law commands that each man after having recuperated physically, pass at least fifteen days in the training school. During this period the patient is able to witness the good effect of re-education and may be won over to take a course if he has been skeptical previously.

Courses are given in shoe-making, tailoring, saddlery, carpentry, bookbinding, basket-making, cart-wright, copper trades, bookkeeping, typewriting, drawing and telegraphy. Many re-educational schools are provided with specially organized departments for agricultural training. The problem of placing the re-educated man, pensions, the assistance given the blind, tuberculous, those facially mutilated, and those whose nervous systems have been seriously impaired are also considered by the author.

Dr. Putti quotes the conclusions of Mr. Chevelley, which were arrived at after an important study of the question: 1. Whenever it is possible, the disabled man ought to be retained in the trade followed by him in the pre war days, or in one similar to it. 2. The above rule ought to be applied especially to agricultural laborers, who constitute in Italy about 85% of the total number of disabled men.—*Mark Cohn, M. D., New York.*

Open Amputation Through the Knee-Joint. By Morris K. Smith, M. D., N. Y., Capt., M. C., U. S. A. *Annals of Surgery*, Vol. LXX, Sept., 1919, No. 3.

The advantages of open amputation through the knee-joint over open amputation through the lower end of the thigh fall under three heads: (1) Less opportunity for bone and avoidance of marrow cavity infection in the stump; (2) improvement in the ultimate stump; (3) lessened operative shock.

We believe that danger and loss of time from bone infection in a stump is minimized by amputation through the knee-joint. It is evident that there is much greater risk from infection when the femur is sawn across, especially in the suppurating cases, than in amputating through the joint, which neither opens fresh bone channels nor the marrow cavity. We have found that these stumps clean up quite satisfactorily, depending on the amount of destruction of the cartilage, and the presence of osteitis in the condyles.

All the open knee-joint amputations require re-amputation. As many of the open thigh amputations require the same thing, with the alternative of an adherent terminal scar, it is not an objection. Amputation through the knee-joint conserves the maximum amount of material for creating a long, serviceable stump when the time for reamputation comes. There is a further advantage with regard to obtaining the most useful stump, namely, that in a certain proportion of such amputations through the knee, the reamputation may be in the form of an osteoplastic between the patella and femur.

Amputation through the knee-joint can be done more quickly and involves less shock than thigh amputations. Not only is there no bone to cut, but the total of soft parts is reduced to a minimum. For this reason alone, we have preferred this operation in critical cases.

Open amputation through the knee-joint, as opposed to open amputation through the lower end of the femur, offers the following advantages: fresh bone and marrow cavity are not exposed to infection; opportunity for a longer, and in some instances an osteoplastic stump; minimum operative shock.—*Leo C. Donnelly, Detroit.*

Treatment of Recent Wounds of the Knee-Joint. By Eugene H. Pool, M. D., N. Y., and John H. Jopson, M. D., Philadelphia. *Annals of Surgery*, Vol. LXX, September, 1919, No. 3.

The pessimistic views which were formerly held in regard to these lesions were due to an undervaluation of the resistance to contamination, and infection which the synovial membrane of a joint offers; and a failure to comprehend the proper operative procedures.

All wounds of joints by projectiles, except certain perforating wounds by bullets, should be operated upon.

A careful preliminary examination of the patient and his lesions is essential. The extent of involvement of the bone and the presence and position of retained foreign bodies should be established by the X-ray. The time elapsed since the wound was received, the location of the wound, the extent of injury

to the soft parts, complicating lesions of the main blood vessels and large nerves, and the general condition of the patient are factors which must be weighed before a plan of action can be decided upon.

Technic: The principles of conservative treatment may be summarized as follows: Complete debridement of the track of the projectile through the joint; absolute closure of the joint by suture; primary or delayed closure of the superficial parts according to the rules laid down for primary suture of the soft parts alone; finally, early active motion.

The incision or incisions must be placed so as to permit not only thorough debridement of the soft parts, but also free access to the foreign body and involved bone. Though no rule can be formulated, longitudinal incisions are to be preferred when practicable. Through the incisions debridement of the soft parts proceeds as in operations elsewhere.

We will consider the simplest type of case: Small perforating and penetrating wounds with little or no bone involvement. The bullet or fragment of shell has either perforated the limb, traversing the joint in its course, or has penetrated the joint and lodged there or in adjacent tissues. In some, it is difficult to determine whether the joint has been penetrated. After the capsule has been exposed, the orifice into the joint must be demonstrated before the joint is opened. Great care should be exercised to avoid opening a joint that is uninvolved. The capsule and synovial membrane should be opened by a liberal incision with thorough elliptical debridement conserving all tissues that can be left safely. Foreign bodies and loose fragments of bone must be removed. The joint is thoroughly irrigated with salt solution and then distended several times with ether. The synovial membrane and capsule are closed with fine catgut. When feasible these two layers should be sutured independently. Complete closure of the joint without drainage is the invariable rule. The soft parts overlying the capsule may be closed or left open for subsequent suture according to the same rules as are followed in wounds of the soft parts alone. In wounds of limited extent operated upon early and retained for observation a primary closure may be practiced. Otherwise the soft parts should be left open. Delayed primary suture may then be made in many cases within a week. Primary suture increases the danger of joint infection by inward extension of a superficial infection, while leaving the soft parts unsutured may delay the institution of early movements.

When the track involves an articular surface with destruction of bone and cartilage, the track must be followed and cleaned as thoroughly as possible.

In some cases, injury to the articular surface, consisting in a limited and incomplete separation of a layer of cartilage with a thin layer of underlying bone, it is advisable to remove the partly separated and poorly nourished layer of cartilage and to cleanse with chisel, gouge or currette, the surface from which it has been detached.

When a considerable area of condyle or articulating surface with a preponderance of bone is partially detached but retains good contact with the overlying soft parts, the fragment is left after the tract has been followed and the fractured surfaces have been cleansed as thoroughly as possible. If an attached fragment is to be removed this should be done if possible by the

subperiosteal method. Compound fractures of the patella should be treated by removal of completely separate fragments and preservation of large attached fragments which should be approximated if possible by suture. Complete removal of the patella should be avoided, since functional result is poor.

In extensive involvement of the articular surfaces, an effort should be made to save the joint, provided the conservable articular surfaces and soft parts are sufficient to warrant a reasonable hope of securing a useful joint. In this connection it must be borne in mind that stability is essential in the knee. When the bone lesion is so extensive as to necessitate resection through the narrow shaft above the condyles, amputation is in general preferable.

When there is such destruction of the soft parts that the edges of the capsule cannot be approximated; if an attempt is to be made to save the joint, the defect in the capsule should be completely closed with muscle or fascia. In cases where this was impossible, we have seen a partial closure made and the wound treated by the Carrel method, the aim being to close the joint subsequently by a plastic operation.

In all cases before the joint is closed complete haemostasis should be obtained. The joint is then thoroughly washed with salt solution to remove blood, bone fragments and debris. This is followed by lavage with ether under sufficient pressure to distend the joint. Closure of the joint is obligatory.

Early active mobilization is the rule. In the treatment of joints associated with fracture, mobilization of the joint is not indicated if it is likely to interfere with alignment of union or promote excessive callus formation. If the joint becomes distended, and infection is suspected, it should be aspirated immediately and a culture made.—*Leo C. Donnelly, Detroit.*

Report of 82 Cases of Knee-Joint War Injuries From Evacuation Hospital 1, A. E. F., With Remarks on the Willems' Treatment by Immediate Closure and Subsequent Mobilization, and the Management of the Subsequent Infection by Drainage and Mobilizations. By Clarence A. McWilliams, M. D., New York. Maj. U. S. Army, Evacuation Hospital 1, A. E. F., Associate Surgeon to the Presbyterian Hospital. *Annals of Surgery*, Vol. LXX, September 1919, No. 3, and Wm. B. Hetzel, M. D., Pittsburgh, Pa., First Lieutenant, U. S. Army, Evacuation Hospital 1, A. E. F., Assistant Surgeon to the Allegheny General Hospital.

Nothing more startling has appeared in the outcome of this war's surgical experience than the surprising good, final, functional results obtained by Willems in his treatment of knee-joint injuries by immediate active mobilization. Under Willems' treatment, patients should not be transported because the journey requires a splint which immobilizes the joint, leading to advanced periarticular oedema and to the deposition of intra-articular fibrin, both of which make more difficult subsequent mobilizing motions. Early evacuations were the rule in the American Army.

General Principles of Willems' Treatment.—Preliminary Roentgen-ray examination of the joint with the object of determining the degree of fracture, if any, also the marking out on the surface of the position of the foreign body beneath. At the operation careful debridement of all the damaged tissues surrounding the wound, external to the opening in the synovial membrane, and the removal of all the hemorrhages in the fascial planes about the wound. Changing the instruments, or re-sterilization before entering the joint. Removal of the coninstruments, or re-sterilization before entering the joint. Removal of the contused edges of the synovial wound with its enlargement up and down sufficiently to do the necessary subsequent work. The joint should be kept open just as short a time as possible in order that the synovial membrane may dry as little as possible, since a dry synovial membrane seems to predispose to ankylosis. Removal of the foreign body, all clothing and loose detached bone fragments. Smoothing off of all rough bone edges. If the foreign body is buried in the bone, it is chiselled away, following the tract to its end and removing all the devitalized bone surrounding the tract. If possible, all the procedures should be performed without the gloved hands being introduced into the joint, or without touching any contacting parts of the instruments to be introduced. At this stage, one will determine whether there is sufficient undamaged articular cartilage left to make possible the hope of subsequent restoration of function by immediate, post-operative, mobilizing movements. The joint is then thoroughly washed out with any bland unirritating solution, such as Dakin's, or normal salt solution; followed by a flushing with pure ether, then the capsular opening edges are completely closed with a plain continuous catgut suture either through and through or so passed that no suture appears inside the joint. Unless the effusion into the joint is frank pus, as in neglected cases, the synovial membrane is completely closed, disregarding the length of time that the injury has existed prior to the operation. The tissues external to the closed capsular wound had better not be closed if the injury has existed over twelve hours. The external open wound may be loosely packed with gauze, wet in Dakin's solution, or Carrel's tubes may be placed in position in the wound for subsequent treatment with Dakin's solution. The important point to emphasize is that the entry in the synovial membrane must be completely closed.

A bandage is so loosely passed about the dressing as not to impede subsequent movements.

At the time the joint is open, a culture is taken of its contents to subsequently determine the presence or absence of haemolytic streptococci which, when found, requires speedy drainage of the joint. No splint should be applied, and this is of great importance.

After Treatment.—Just as soon as the patient is out of the anaesthetic he is made to actively (never passively) move the articulation in bed. Passive motions are painful and set up an inflammatory reaction, and later may cause an extra-articular abscess to rupture into the joint. The patient's hands grasp the sides of the thigh, which is lifted from the bed by muscular contractions, his heel remaining at rest on the mattress. At first there is excessive fear of trying these motions but as the pain is felt to be very slight courage is soon established. The sooner motions are begun after the operation the less is the

pain, because the peri-articular structures do not have time to become infiltrated with exudate. The nurse sees that this is done every two hours night and day, to the greatest extent possible short of actual pain. To the faithfulness of the nurse in following these instructions will be due the subsequent restoration of function. There is astonishingly little pain when active motions are started immediately after the operation providing no bony fragments are displaced, in which case movements are not indicated. Patients say that if painful sensations appear during repose, the best way to make them disappear is to repeat the movements.

There will frequently occur, after the operation, a hemorrhagic effusion into the joint, upon the appearance of which motions become to a greater or less degree impossible, depending upon the amount of fluid present. This should be at once aspirated, to be followed immediately by the resumption of the active motions which become possible as soon as the joint is emptied of fluid. It may be necessary to aspirate the joint a number of times, a bacteriological test being made each time to determine the presence or absence of infection.

The patient on the second or third day is made to get out of bed and take a few steps without crutches. It is astonishing how little pain is experienced on walking, if active motions have been begun immediately after the operation, and how soon almost perfect function is restored.

Management of Septic Knee-Joints from War Injuries.—As soon as frank pus is evident, either by sign of inflammation or bacteriological examination, thorough drainage must be at once established by vertical external and internal incisions. The joint is washed out thoroughly with Dakin's solution at the time of the operation. Tubes should preferably not be used at first but may be later if drainage is found to be insufficient. When they are used, the internal ends should project just inside the synovial membrane and no further. The after treatment is conducted exactly as in the case of noninfected joints by active (not passive) motions carried to the point of pain. These are begun immediately after the anaesthetic has worn off and are repeated every two hours thereafter, day and night. Even a day's delay will prejudice the final functional results. Walking is important because the muscular contractions compress the joint and cause a marked increase in the expulsion of pus. The patient is made to walk the next day after the operation without crutches. It is surprising how much pus will exude from the incisions after each walk. It is very important that sufficient drainage openings be made to allow for an adequate escape of pus. These openings should be sutured joint as soon as the discharge becomes serious. If the active motions are performed often enough and vigorously enough, these secretions are expelled through the drainage openings as they are formed. Drainage seems to be more thoroughly accomplished by this method than by any other, thus limiting the infection to the synovial membrane and tending to prevent its spread to the cartilage and bones.

In civil injuries the results of operations with debridement, joint closure and immediate subsequent mobilization should be much better than in war injuries, because ordinarily the patient is operated upon more quickly, the infection is not so virulent, there is no transfer to another hospital, and the after-nursing should be more effectually done.

The following are the divisions of joint lesions by projectiles as made by Willems.

1. Simple traumatic hydrarthrosis or haemarthrosis without penetration of the joint cavity. This requires immediate aspiration with no subsequent splinting. We do not ordinarily aspirate these joints early enough or often enough. Active motions of flexion and extension with walking on the knees at once should be instituted. This is a radical departure from the old fashioned immobilization, and it is quickly very successful. That the abolition of movements is due simply to the presence of the fluid is shown by the fact that movements are possible immediately following the emptying of the joint.

2. Joint Wounds Without Injury to the Bone.—The treatment for this is outlined above in the previous part of this paper. Sometimes, while active motions are going along well, there will be a sudden functional impotence. Examination will show an effusion into the joint. This must be aspirated at once and a culture taken. Upon removal of the fluid active movements and walking should be made as before the aspiration. The aspirations may have to be repeated several times.

3. Articular Wounds with Small Bony Lesions.—Among these are the perforations of the epiphysis, erosions of the cartilage, the raising up of bone fragments from the surface and losses of deeper fragments but which are superficially small in extent. All these lesions have this in common that they leave intact the greatest part of articular surface, and there is no great fragment detached or detachable, consequently there can be no displacement by motions. The post operative treatment is exactly like that of articular wounds without bone injury.

4. Articular Wounds with Bony Lesions of Medium Severity.—By these are meant those wounds in which an important fragment of an epiphysis is detached. These are the oblique transcondylar fractures. The danger in them is the dislocation of the articular line. Active immediate mobilization should be begun at once, but in the knee, walking should be interdicted for about three weeks in order that sufficient consolidation should take place to prevent displacement of the fragment. In fractures of the patella, Willems encircles the fragments with a buried silkworm-gut suture and treats them afterwards with active motions and immediate gentle walking. His results are excellent.

5. Articular Wounds with Large Bony Fragments.—When the fracture is one of the varieties of theT-fracture, the limb must be submitted to continuous extension, mobilizations being delayed for consolidation in order to preserve the articular line.

In conclusion the authors desire to quote Dr. Willems in the following summary of the rules which are essential to be followed in carrying out this method:

Active mobilization should be begun without any delay and should be carried as far as the patient is in condition to do it. It should be done without interruption, even to the point of fatigue. This mobilization is not painful in the true sense of the word, it is only laborious. It is necessary to compel the patient to do it, to tease him if he is lacking in courage.

"It is never necessary to add passive movements to the active movements with the expectation of hastening the process.

"Patients treated by this method never present any serious alteration of their general condition, even during the early febrile period. They never look like those who have been severely infected. They do not fear movements as do those who are immobilized. Even in purulent arthritis it is striking to note that the joint has not the excessive sensibility which an infected joint presents when it is cared for by immobilization."—*Leo C. Donnelly, Detroit.*

EARLY SURGICAL AND ORTHOPAEDIC TREATMENT OF HEMIPLEGIA. By Jos. Byrne, M. D., M. R. C. S., Alfred S. Taylor, M. D., F. A. C. S., and Samuel W. Boorstein, M. D., New York. *Surg., Gyn. and Obst.*, Vol. XXIV, Oct., 1919, No. 4.

CONCLUSION AND SUMMARY.

1. Early operation within 2 to 4 weeks, or even after a much longer period, may be indicated in hemiplegia—

(a) Where the intracranial pressure threatens medullary strangulation, no matter what the site or nature of the lesions;

(b) In extradural haemorrhage with or without intradural haemorrhage or cerebral contusion, where cerebral compression threatens life or permanent dissability.

(c) In intradural haemorrhages of traumatic or spontaneous origin where cerebral compression threatens life or permanent disability.

(d) In intracerebral haemorrhage where focal compression threatens life or permanent disability.

2. A subtemporal decompression and evacuation of the clot is a simple procedure and should be used in every case of fresh hemiplegia where the abovementioned indications are present.

3. If the patient be unconscious, an anaesthetic need not be used, as the shock of the operation is small.

4. Even in old cases of hemiplegia decompression is of benefit.

5. Decompressions should be used even in cases due to embolism or thrombosis.

6. The deformities and contractures of hemiplegia can be prevented.

7. Patients with hemiplegia should be put in the same category as anterior poliomyelitis and receive proper orthopaedic treatment from the beginning.

8. Plaster splints should be applied immediately to prevent contractures.

9. Massage and exercises are indicated and should be used intelligently.

10. Proper use of the limbs should be shown to the patients and encouraged.

11. In old and neglected cases deformities should be corrected and recurrences prevented.—*Leo. C. Donnelly, Detroit.*

Cases of Primary Suture. Ten Cases of Primary Suture of the Joints. LeFur, R., *Paris Chirurg.*, 1918, X, 400, 455. *Surg., Gyn. and Obst.*, October, 1919, No. 4.

From the results in this series, he draws the following conclusions:

1. In cases of joint wounds it is always more prudent and often necessary to open the articulation by a wide arthrotomy and to disinfect it thoroughly.

2. The disinfection and cleansing of the joint should be carefully done and complete. The arthrotomy should be large enough to expose the whole wound tract, the synovia, the cartilage and the bone regions, and to permit the removal of every particle of debris. The interior of the joint should be washed with ether.

3. Unless contra-indicated, the suture of the joint should be complete and a drain should not be used. The harm of drainage in joint wounds has been fully demonstrated. Drains favor infection and cause ankylosis. When drainage is necessary, the small Dakin drains should be used with continuous or interrupted irrigation with the Dakin fluid. These drains should be changed every day or every other day.—*Leo C. Donnelly, Detroit.*

Bone and Joint Lesions of Yaws With X-Ray Findings in Twenty Cases. By Maj. Herman G. Maul, M. C., U. S. A. From the Laboratory and X-Ray Department Hospital, Manila, *The American Journal of Roentgenology.*

In the majority of cases the lesions show as rarefied areas, irregularly oval or elliptical in shape, with the long axis parallel to that of the bone in which the lesions are located. The size varies from the smallest descernible area to one that is 2 or 3 centimeters in length. The rarefication presents moderately well defined borders separating it from the unaffected bone and varies in translucency from the slightest differentiation of unnatural transparency to one stimulating a perforation. Most of the lesions appear to originate in the interior of the bone, while a number can be seen as small excavations on its outer surface. When the lesion is on the surface of the bone, the periosteum is usually destroyed, but occasionally the cortex shows thickening, and the periosteum is separated from the bone. In two cases of this series there is a general thinning of the cortex of the bone and a loss of the cancellous-tissue appearance. About 2% of the cases show a nodular type of lesion, evidenced by swelling over the surface of the bone, with a localized thickening of the cortex, which sooner or later in the course of the disease shows rarefacation in its center.

In the chronic lesions marked irregularity of the bony outline is evident, and the picture characteristic of the earlier lesions is more or less lost. The bone as a whole becomes deformed, and the growth of the bone is interfered with both in length and breadth. This dwarf-like picture is most frequently noticed in the cases showing the lesions in the epiphyses. Within the joints the destruction is most frequently seen on the parts of the articular surfaces most exposed to trauma, as oval or irregularly shaped excavations, making the

outline of the articular surface rough and uneven. It is concluded from this series of cases that the joint pains complained of are due in most part to the presence of the lesions of the articular surface.

With the exception of the 2% of cases showing as a swelling over the surface of the bone, the roentgen ray picture is different from the bone lesion of syphilis in that: (1) The periosteal proliferation is absent, and (2) the thickening of the cortex of the bone is absent. Also, in the 2% of cases where thickening of the cortex is present, the thickening remains localized, does not tend to extend along the whole length of the bone, and sooner or later shows rarefication in the center of the lesion.

The bone lesion of yaws may stimulate (1) tuberculous or septic central abscesses, (2) gumma, (3) hydatic cyst, (4) benign cyst, (5) fibrous osteitis, (6) enchondroma, (7) endothelioma, (8) secondary carcinoma, (9) myeloma, and (10) sarooma. The differential diagnosis can be made only by combining the radiographic appearances with all clinical data, including the history, physical signs, and evidence of disease or tumor in other parts of the body.—*Leo C Donnelly.*

Vol. I, No. 12 DECEMBER, 1919 Old Series: Vol. xvii, No. 12

The Journal of Orthopædic Surgery

CALCANEO CAVUS AND ITS TREATMENT

By Major Naughton Dunn, R. A. M. C., Birmingham.

Paper read at the meeting of the British Orthopaedic Association, 30th May, 1919.

Calcaneo Cavus and Its Treatment.

Calcaneo Cavus is one of the most crippling of the deformities which follow Infantile Paralysis.

The condition demands special consideration by the Orthopaedic Surgeon, because once the deformity is established, treatment by splintage is difficult and usually ineffective.

Many of the appliances supplied by the instrument maker are heavy and cumbersome and when removed the deformity is seen to be still present.

In the early stages of this condition, the child is unable to raise the heel from the ground in walking, later the heel drops, the pillars of the longitudinal arch of the foot are drawn together and eventually the heel becomes a peg on which the patient walks, while the anterior portion of the foot becomes an atrophied and useless appendage. Associated deformities of the foot, such as Varus and Valgus will also tend to develop, owing to faulty incidence of body weight or unequal muscular action.

Cause of Calcaneo Cavus and Associated Deformities.

In Infantile Paralysis we notice that where paralysis of all the muscles controlling the foot is complete, there is usually little actual deformity. Where the deformity is most marked we know that some muscles are active; this is always the case in Calcaneo Cavus deformities.

The increase of deformity appears to be due, not to the paralysis of the Tendo Achilles, but to the effort of the other posterior Tibial muscles to assume its function and to the unopposed action of its antagonistic muscles. If the calf muscles are paralysed or much weakened the Tibialis Anticus and Posticus pull up the arch, while the flexor longus digitorum, flexor longus hallucis and Peroneus longus, passing down behind the ankle to their insertions in the front of the foot, draw the pillars of the arch together. As a result the heel drops, the arch rises and the structures on the plantar surface of the foot shorten.

The greater power of the Peroneus Longus frequently accounts for the commonly associated Valgus deformity.

If you examine a radiograph of a typical case of Calcaneo Cavus you will see that the antero posterior arch of the foot is high, and if you examine it more carefully you will see that this is due mainly to a tilting upwards and forwards of the forepart of the os calcis on the astragalus, and a dropping of the forepart of the foot at the medio tarsal joint. The relation of the astragalus to the bones of the leg is not much altered, but owing to the stretching of the posterior ligaments of the ankle from continued strain, the line of the body weight tends to pass almost entirely through the posterior astragalo-calcanean facet to the point of the heel.

Normally the weight of the body is transmitted to the foot through the astragalus, directly to the Os Calcis and indirectly through the Scaphoid and Cuboid to the forepart of the foot.

Movement at the subastragaloid joint is normally slight, but in any deformity of the foot resulting from unusual strain or loss of muscular balance, the relation of the astragalus to the os calcis is altered, although the range of movement occuring at this joint may remain the same. If the astragalus and os calcis were one bone, body weight would be mainly transmitted directly to the os calcis and the effects of dynamic pressure on the weakened muscles and ligaments would not be so often apparent.

I would therefore suggest that in any case of tendency to deformity following Infantile Paralysis, arthrodesis of the subastragaloid joint should at least be part of any operative procedure.

Treatment of Calcaneo Cavus and Associated Deformities.

No agreement has yet been reached by Orthopaedic Surgeons as to the treatment of this condition.

The published methods of which I have had experience are:

1. Shortening of the Tendo Achilles and plication of the posterior portion of the capsule of the ankle joint. This operation has been advised in cases where there is weakness but not paralysis of the Tendo Achilles.

By this operation the weak muscle is permanently stretched. This is a direct contradiction of the axiom, on which we are, I think, all agreed, that relaxation will hasten the recovery of a muscle, which is too weak to perform its function.

This operation may therefore be discarded as unsound both in principle and practice.

2. Davis of Philadelphia makes a transverse incision through the subastragaloid joint, displaces the foot backwards, and if necessary, transplants the peroneal and posterior Tibial Tendons into the Os Calcis.

The results of the operation are good in mild or moderately severe cases. The displacement of the foot backwards is difficult, but the arthrodesis of the subastragaloid joint which results, is a most important factor in increasing the stability of the foot.

3. *Whitman's operation.* Whitman advises the removal of the astragalus through an external incision, the articulating surfaces of the leg bones and os calcis are denuded of cartliage, the foot is then displaced backwards, so that the malleoli overlap the anterior portion of the os calcis. The peroneal tendons, if active, being inserted into the os calcis. The foot is then fixed in plaster in the equinus position with slight valgus for about six weeks and later a brace applied to give further support for some time.

The object of this procedure is to throw the weight of the body more on the centre of the tarsus, so that the cavus is gradually corrected and the security of the foot maintained. My experience of this operation is that it gives a more stable foot, but should recovery take place in the Tendo Achilles or the muscles replacing it, the short fibrous ankylosis resulting does not allow a useful range of movement. Another point to be considered is that the limb is further shortened by ½″ to ¾″ by removal of the astragalus. It should, I think, be reserved as an alternative operation for cases in which paralysis of all the posterior tibial muscles, as well as the Tendo Achilles, is complete.

Case Shown.

A recent cast of a case operated on by this method 4 years ago. The child has now walked for 2½ years without any form of support. There is no tendency to increase of deformity, but the child has not as much control of the foot, as might have occurred if more movement of flexion and extension were possible between the leg bones and the foot.

4. Where paralysis of the calf muscles is complete, the double wedge operation, as practised by Sir Robert Jones has given good results in a large number of cases. The steps of the operation, as published 11 years ago are:

Stage I.

Step 1. If the Plantar fascia is contracted, divide it subcutaneously and straighten the sole by manual or instrumental force.

Step 2. On the inner side of the foot make a 3 inch incision to the bone, the centre of the incision being opposite the convexity on the dorsum. Separate the soft parts from the tarsus with an elevator until the inner dorsal and plantar surfaces are accessible.

Step 3. With a chisel remove a wedge of bone (base above) large enough to completely correct the cavus.

Step 4. Close the wound, correct the cavus by flexing the foot dorsally, and after applying dressings, bandage the foot to the tibia. The cavus is cured, but the calcaneus is apparently much worse.

Stage II. (Four weeks later.)

Step 1. Make a longitudinal incision at the back of the heel, the centre being opposite the ankle joint. Open the joint.

Step 2. Remove a wedge from the Astragalus sufficient to permit the foot being brought at a Right Angle to the leg and arthrodese to the Tibia.

Step 3. Close the wound. Correct the deformity. Immobilise until union is complete.

The results are in many cases excellent, but unless arthrodesis of the subastragaloid joint is also assured, lateral displacements of the os calcis on the astragalus may still occur and give rise to valgus or varus deformity.

The conditions vary so much in each case that it is not possible to publish the various points, which guide one in the treatment of an individual case.

Before deciding on a line of treatment all factors must be considered, the age of the patient, the cause of the deformity, its degree and probable progress, and, perhaps most important of all, an accurate estimate must be made of the power in each muscle controlling the foot.

Our consideration of these points can only be effective if we also recognise the relative importance of the various movements of the foot. The human foot is adapted mainly for support and locomotion, and for these it depends largely on its muscular control. The most important movements in propulsion of the body are controlled flexion and extension of the foot at the ankle. We must therefore endeavour to retain these, sacrificing elasticity if necessary. We can assure stability by substituting bony for ligamentous union between the mediotarsal and subastragaloid joints.

For actual muscular control of extension of the ankle we must depend as a rule on transplanted muscles, but we can make their action more effective if necessary by displacing the foot backwards and so increasing their leverage.

I propose to give in detail the methods I have found most effective.

Case 1. Tendo Achilles weak, no deformity,—child does not raise heel from the ground in walking and is unable to stand on tip-toe. Passive dorsiflexion of the foot greater than on normal side.

Treatment. Fixation of the foot in equinus position for three to six months, followed by a brace to prevent dorsiflexion of the foot beyond a right angle and raising the heel of the boot half an inch.

Massage, electrical treatment and controlled exercises should be continued.

This postural and direct treatment of the muscles will also be advisable in the after treatment of all cases in which operation has been found necessary.

Case 2. Similar to Case 1, but dropping of the heel more noticeable and some cavus present.

Treatment. Arthrodesis of the subastragaloid joint. This is performed through lateral incisions below each malleolus,—the foot being displaced backwards. This is followed by postural treatment as in Case 1.

Case 3. No power in Tendo Achilles, but other posterior tibial muscles active. Heel walk more apparent. Moderate cavus present with some contracture of the plantar fascia. Complete passive correction of the calcaneus deformity still possible.

Treatment 1. The Plantar fascia is divided and the sole of the foot straightened out by manipulation.

2. The subastragaloid joint is exposed through posterior incision, and the cartilage removed from its surfaces. The Peroneus Longus, Flexor Longus Hallucis and Flexor Longus Digitorum are transplanted to an insertion in a groove on the posterior surface of the Os Calcis. The foot is then fixed in the equinus position for eight to ten weeks. After-treatment same as in Case 1.

Case 4. No power in Tendo Achilles, other posterior tibial muscles hypertrophied, complete heel walk with extreme cavus. Passive correction of cavus and calcaneus deformities is not possible.

The patient has been walking on the posterior surface of the heel for years, and the fore-part of the foot has become a useless appendage.

This is the most satisfactory type of case from the Orthopaedic surgeon's point of view, as the greater the degree of deformity, the most satisfactory the after result is likely to be.

Treatment 1. The plantar fascia is divided with a tenotome, and the cavus deformity corrected as much as possible by manipulation or moderate wrenching. If we attempt to exert the extreme force of the Thomas Wrench in such a case, a plantar dislocation of the fore part of the foot results.

2. Through a four inch incision over the outer part of the dorsum of the foot between the tendons of the extensor longus digitorum and the peroneus tertius, a clear subperiosteal exposure of the mid tarsus is obtained. A bony wedge is then removed, base upwards, which allows correction of the cavus deformity. This will involve the greater part of the scaphoid and the calcaneo cuboid joint.

3. The child is next turned on its face and a long shaped incision made over the posterior surface of the ankle.

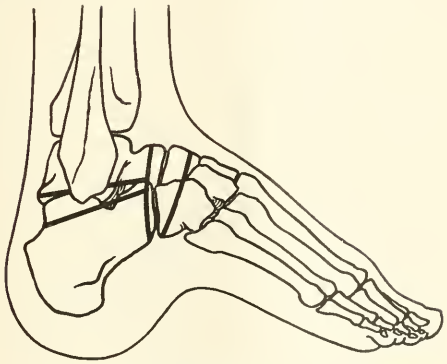


FIG. I

Showing Wedge of Bone Removed

The Tendo Achilles is retracted and all the remaining tendons of the Posterior Tibial and Peroneal groups exposed and divided as far forwards as possible.

A wedge of bone, base backwards, is now removed from the astragalus and os calcis. The wedge should include the subastragaloid joint and extend forwards to the mid tarsal resection. It should be cut so as to allow easy correction of the calcaneus, as well as any associated valgus or varus deformities.

The foot may now be looked upon as consisting of three sections:

An Upper, formed by the portion of the astragalus articulating with the tibia and fibula;

A Lower, formed by the remainder of the os calcis; and an Anterior, consisting of a portion of the scaphoid and cuboid bones, with the remaining fore-part of the foot.

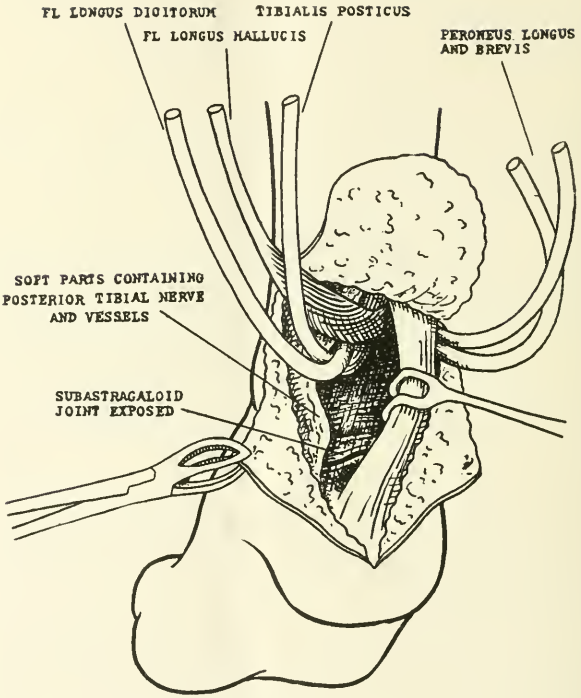


FIG. II

Deep Tendons Isolated and Subastragaloid Joint Exposed

4. The Tendo Achilles is next split into an anterior and posterior layer in its lower two inches. With a small gouge, passed between these layers, a hole is bored in the posterior extremity of the os calcis. This must be large enough to receive the transplanted tendons.

The foot is then put in the equinus position and the tendons cut so that when taut they just pass into the bed prepared for them in the receiving bone. The lower two inches of the transplanted

tendons are first roughened with a scalpel or toothed forceps, so that they may readily unite with the recipient tendon.

The Peroneus brevis and longus are then united to one another by means of chromicised catgut and guided into the groove prepared for them in the os calcis. The same procedure is adopted with the flexor longus hallucis, flexor longus digitorum and tibialis posticus.

The method of fixing these tendons in the groove is, I think, important:

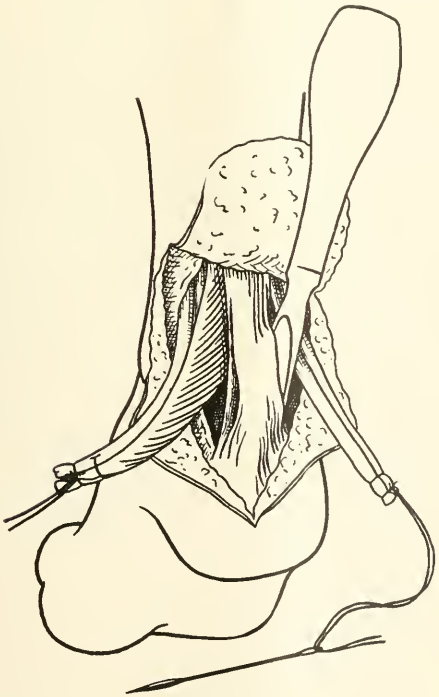


FIG. III

Deep Tendons Sutured in Two Groups. Bed Prepared in Os Calcis. for Their Reception.

The tendons are cut the required length, No. 3 Chromicised catgut is used, either as a loop or suture, to unite the extremities of each group of tendons. Each catgut is then threaded on a long straight needle, which is passed between the two layers of the tendo achilles and through the groove in the os calcis to emerge on the sole of the foot. The two loops are brought to the surface about ¼" apart. Then, while the position of the plantar flexion of the foot is maintained, these directing catgut sutures are tied on the sole of the foot over a small pad of gauze.

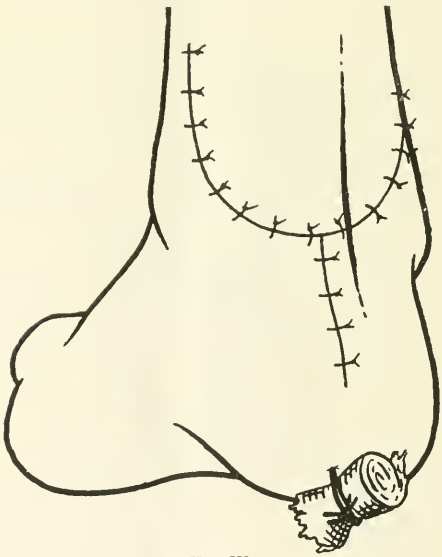


FIG. IV

Operation Completed. The Deformity is Corrected. The Sutures Holding the Deep Tendons in Their Bed Are Tied Together Over a Pad of Gauze under the Heel.

The transplanted tendons are thus fixed in their bed, while further sutures are introduced to fix them to the Tendo Achilles.

A sole splint is then applied to maintain the correction of the cavus deformity, and the foot is encased in plaster of paris in full

equinus for six to eight weeks. Postural and general treatment should be continued for another two to three months.

The result in these cases as regards function is excellent, and has in my experience withstood the test of time.

Case 5. Here we have some power in the anterior tibial muscles, but none in the tendo achilles, and little or none in the posterior tibial muscles. If any power is present in these it is often unequal, and a lateral deformity, usually valgus, is present as well as the calcaneus.

Treatment. The cavus deformity is first corrected by free removal of bone. The wedge removed may include the whole of the scaphoid and the articular surfaces of the astragalus and internal cuneiform bones, as well as most of the cuboid and its articulation with the os calcis.

Then through a posterior incision the cartilaginous surfaces of the astragalus, tibia and fibula are cut away, and a posterior wedge is removed, which includes the subastragaloid joint, and is sufficient to allow the foot to be brought into the straight or slightly equinus position and also to be displaced backwards in relation to the tibia and fibula. It is fixed in this position for eight to twelve weeks.

We thus obtain a short stable foot, which acts mainly as a peg, controlled by the knee joint.

The shortening of the foot in this case is not a disadvantage, and the arthrodesis of the ankle, subastragaloid and medio tarsal joints, gives the stability necessary for function.

All the operations I have described may be completed in one stage.

I am much indebted to Capt. W. H. Ogilvie for kindly preparing the illustrations shown.

TUBERCULIN

Its Use in the Treatment of Bone and Joint Tuberculosis.

By S. Kleinberg, M. D., New York City.

The literature on the use of tuberculin for therapeutic purposes is very voluminous. Though tuberculin has been used in the treatment of tuberculosis of glands, kidneys, bones and joints, skin, etc., it has received its widest and most thorough application and test in the treatment of tuberculosis of the lungs. In judging of its value, therefore, we would naturally consult the records of its administration in cases of pulmonary tuberculosis.

Perusal of the more recent articles shows that most of the observers consider tuberculin of great help in pulmonary tuberculosis. Some men believe that tuberculin actually cures pulmonary tuberculosis. Others are convinced that tuberculin, while it may not be curative, is, nevertheless, essential in the immunization and management of tuberculous patients; while still another group of men believe that tuberculin is not a specific or curative, but is an important adjuvant in the treatment, acting as a strong stimulant. Sahli believes that tuberculin is destined to fill as important a place in the fight against tuberculosis, as vaccination does in small-pox. Karl Von Ruck is very enthusiastic about the curative influence of tuberculin. He reports that out of a total of 4,000 cases of pulmonary tuberculosis treated with tuberculin, 49% were cured at the time of discharge from the hospital. Trudeau writes "I believe that, if skillfully used, tuberculin stimulates the defensive resources of the organism, and is a valuable adjunct to treatment in many cases." G. R. Pogue in a review of 167 cases treated with tuberculin, reaches the following conclusions: "1—Valuable aid, 2—Tuberculosis may be arrested by proper treatment, 3—Cases treated with tuberculin show less tendency to recurrence." E. R. Baldwin states that "Tuberculin may work much good in some patients by lessening the sensitiveness to itself." Fremont-Smith is in favor of its use. He concludes that "Tuberculin watchfully employed produces a check in the downward progress, a commencement of the building up." Lawrason Brown is in favor of its use. Lyons treated 100 cases with 72% improvements. Shively is of the opinion that "It is certainly true that in many cases this (the patient's resistance) can be developed and strengthened by immunizing doses of tuberculin."

Other observers, these form the minority, are more conservative in their estimate of the value of tuberculin. Walter C. Klotz in a very convincing article states that the best and the most we may expect of tuberculin is that it acts as "an important adjuvant to the long and expensive hygienic treatment."

Two facts are evident from the literature. First, that tuberculin has been given an extensive trial by many men in the management of pulmonary tuberculosis. Second, that most of the investigators, and among these are men whose opinion bears great weight, believe that tuberculin has a very definite and more or less valuable place in the treatment.

In cases of bone and joint tuberculosis, tuberculin has been used but little, and by only a very few orthopaedists. Dr. John Ridlon some years ago used tuberculin, and concluded that in some cases there was no influence on the disease, while in others there was distinct injury to the patient, and aggravation of the tuberculous process.

Dr. Chas. Ogilvy in a study of tuberculin concludes that "Tuberculin in small does at proper intervals is of undoubted value in the treatment of selected cases of tubercular bone and joint infections."

Nutt and Hastings used tuberculin in a fairly large number of cases of bone and joint tuberculosis. They concluded that "Tuberculin is of decided value in the treatment of tubercular joints. It may be administered during any stage of the disease." These authors cite many of their cases as improved. They interpret the improvement as the direct result of the use of tuberculin. In most of the cases, however, judging from the description, the improvement is not marked, and might very well have occurred without the use of the tuberculin. The period of observation was too short to allow one to judge of any permanent changes. There were several cases of negative results. In general the observations made by these investigators did not, it seemed to me, offer convincing proof of the value of tuberculin.

Thus, the literature taught us that while internists had great faith in the healing influence of tuberculin in pulmonary cases, in surgical or bone and joint cases, the results of the use of tuberculin were not specially encouraging. However, it was also evident that tuberculin had not been given a sufficiently long or extensive trial

in orthopedic cases, and that criticism of the value of tuberculin in such cases would be unfair. Furthermore, the orthopedists had used tuberculin in either single, fairly large doses, or had repeated the same dose at short intervals. Thus they frequently got severe constitutional reactions. In recent years, the belief has grown that for therapeutic purposes tuberculin should be given in increasing doses, and regulated to avoid a reaction. This reactionless method of tuberculin administration attracted my interest as it seemed reasonable, and there was no report in the literature of its application to bone and joint cases. I, therefore, set out to test the value of tuberculin administered to bone and joint cases in increasing doses, and by the reactionless method.

For the proper management and treatment of a case of bone and joint tuberculosis with tuberculin, there are three essential factors. First, a correct diagnosis. Second, a thorough knowledge of the symptoms, course of the disease and likely complications. Third, an accurate knowledge of the dosage of tuberculin and its action.

Correct Diagnosis: It may perhaps be superfluous to direct attention to the importance of a correct diagnosis. Nevertheless, where a medicine is still in the experimental stage, and tuberculin certainly is that, it is especially important that we treat the disease we intend to treat so that our conclusions may be worth recording. I am prompted to emphasize this point from a very striking experience. A case was presented to me as demonstrating the curative effect of tuberculin. The patient was a girl 8 or 9 years old, who was supposed to have had tuberculosis of both hips and was cured by tuberculin. She was extremely well nourished, did not limp, and showed no evidence of any previous abscesses or sinuses. Both hips were slightly limited in abduction, but otherwise normal. There was no shortening, adduction or flexion deformity. There was no sensitiveness of either hip joint. All the motions of the hips except abduction were entirely free and painless. I grew curious and asked for the radiogram taken before treatment was begun. This showed flattening of the femoral head, and broadening of the neck in each hip, radiographic signs that are characteristic of Perthes' Disease. This was not a case of tuberculous hips at all. Under the restrictions incidental to the course of intensive tuberculin treatment, and from the accompanying enforced rest, this patient improved as practically all cases of

Perthes' Disease do with rest. But because of the erroneous diagnosis, this patient was paraded as exemplifying a tuberculin cure.

Course and Complications of Tuberculous Osteitis and Arthritis: Tuberculous disease of bones and joints is a slowly progressive and destructive process. Under favorable hygienic surroundings, and with appropriate orthopaedic treatment, it frequently has remissions. During the quiescent period the lesion gives few, perhaps no subjective symptoms, and the destructive process is at a standstill, with no increase in the objective findings. Such a period of quiescence may last weeks, months or years, when with or without apparent cause there is a relapse, a flaring up of the lesion with marked symptoms. It is practically impossible to decide whether a given tuberculous lesion, except perhaps one that has been completely eradicated by operation, is cured—never to recur. I have a patient 39 years old who has a tuberculous hip which was quiescent for 20 years, and then became active. Dr. Gibney related the instance of a woman who for 50 years had a discharging sinus and no other symptoms of a tuberculous joint. During this long period of years the sinus would open, heal up and reopen at irregular intervals. All of us know of tuberculous patients who are free from symptoms for varying periods, and then show signs of an active disease. All of which goes to prove that a tuberculous patient who shows no symptoms of active disease for a limited time is not necessarily cured. On the contrary, experience teaches us to be skeptical, and to expect that during a moment of diminished resistance or without apparent cause, symptoms will reappear.

The commonest complication of bone and joint tuberculosis is an abscess. An abscess may persist for a long time and be absorbed. It may discharge spontaneously and disappear, or leave a sinus. When artificially evacuated it may disappear or leave a sinus. Most frequently there is a resultant sinus which may last a long time and heal up, or may be closed and discharging at irregular intervals. The closure of a sinus does not perse signify that the underlying causative lesion in the bone or joint is entirely healed or healing. Last but not least, we must not overlook the fact that under orginiary hygienic, conservative and orthpoaedic treatment some tuberculous arthritides heal by fibrous or bony ankylosis.

It is well also at this point to emphasize the fact that a patient

receiving tuberculin visits the physician at least twice a week for many, many months. The parent or guardian and the patient himself are so thoroughly impressed with the gravity of the condition, the importance of treatment, and the necessity for constant watchfulness, that the patient receives unusually good care. Tuberculin treatment requires taking of the patient's temperature about four times a day, and a keen lookout for unusual symptoms indicating a local or constitutional reaction. Any treatment requiring such close observation of the patient inevitably leads to unusual care. As a result of this careful and unusual supervision, the patients eat well, rest sufficiently, seek the fresh air frequently, and in general live a more wholesome and healthful life which is conducive to improvement of the patient and of the tuberculous lesion. We must take this into consideration as it probably accounts for a considerable portion of the improvement. Dr. Whitman has often remarked that every new treatment has some advantages. The physician in charge is enthusiastic, and through him the patient and parents become hopeful. A proper atmosphere for improvement is created, and the patient benefits thereby. Recently I had charge of the orthopaedic treatment of the children at the Neponsit Beach Hospital. These children are all tuberculous. It was very interesting to see the change in the children within a fortnight after their admission to the hospital. With no other change than the administration of plenty of wholesome food, living in the fresh air the major part of the day, and rest, the children who came in dull and pale, without appetite and sickly, became bright, happy, hungry, smiling and rosy cheeked,—all the result of an improved environment.

The above characteristics of bone and joint tuberculosis have been reviewed so that we may keep them constantly in mind in discussing tuberculin therapy. When in the course of tuberculin therapy, symptoms subside, we must carefully weigh the evidence and decide whether the improvement is the direct result of the specific treatment, a likely occurrence in the course of the disease, or merely incidental to intensive care.

Dosage of Tuberculin.—It goes without argument that he who intends to use tuberculin must acquaint himself thoroughly with its action. Tuberculin may be very toxic, and if unwisely or improperly administered may do great harm, even to the point of killing the patient, so great care must be exercised in its usage.

In order to acquaint myself thoroughly with the dosage and pharmacology of tuberculin, I spent many months at the tuberculin therapy clinic of the New York Polyclinic Hospital where I studied the theory and practice of tuberculin therapy, and learned the method of administration of tuberculin in increasing doses. The method of dilutions and dosage, by the way, is extremely simple and is easy to apply. The great and only serious danger comes from indifference in preparing the various dilutions, so that a much larger dose of the drug shall not be given than is intended.

We all realize the imperative need of a specific in tuberculosis of bones and joints. In adults we frequently are able to rid the joint of the tuberculous infection by thorough operative removal of the diseased tissue. In children, and it is among these that we see most of the cases, radical treatment is contra indicated, and a medical cure would indeed be a blessing and most welcome.

In 1914 the writer was very much impressed with the large number of bone and joint cases which were being treated with tuberculin at the Polyclinic Hospital. Dr. Bonime, the chief of the tuberculin department, spoke very enthusiastically in favor of tuberculin. He insisted that the failures from tuberculin treatment in the past were due to improper dosage, and that with the method of gradually increased doses "we may consider the curability of bone and joint tuberculosis as complete."

Theoretically, it was argued that the injection subcutaneously of increasing doses, beginning with small innocuous quantities, would cause the manufacture in the blood of substances that would destroy or lysinize the tubercle bacilli. If the tuberculin is given in increasing and properly regulated amounts, not only would the tubercle bacilli gradually be killed off, but the patient would become resistant to tuberculous invasion through loss of hypersusceptibility to the tubercle bacilli. Thus both the patient and the local process would be cured. The theory sounded reasonable and attractive. In the course of my observations at the Polyclinic Hospital, I saw many patients who at first gave local and constitutional reactions from very small amounts of highly diluted tuberculin, and finally assimilated fairly large doses of pure tuberculin, without any reaction. It was argued that if these patients can take by subcutaneous injection pure tuberculin without reaction, they must have acquired a tolerance for, and an immunity to tubercle bacilli, and that they were therefore cured of their tuber-

culosis. The weak point in this argument will become apparent later.

However plausible the theory sounds, my experience with the many patients I observed at the Polyclinic Hospital was not convincing, for I did not see a single case of bone and joint tuberculosis cured. Since, however, many of the cases had insufficient orthopaedic treatment, I decided that it would be wiser and fairer to take a series of cases, and besides giving them tuberculin apply appropriate orthopaedic treatment. My series included a few private patients and the rest from the services of Drs. Gibney and Whitman at the Hospital for Ruptured and Crippled. I was particular to take the cases as they came along, the mild with the severe, instead of selecting any one type. My series included cases of tuberculosis of the spine, hip, knee, ankle, shoulder and elbow joints. Moreover, many of these patients had been under observation for some time before, so that we had knowledge of the previous course and were in a position to adjudge any changes, and to determine if they were the result of the introduction of tuberculin. My observations lasted over a period of two years, and while this length of time in a consideration of tuberculous joints is not sufficient to permit of a final opinion, yet the experiences were such as to warrant definite conclusions.

In many instances where there were secondary infections, as from a discharging abscess, antogenous vaccines were employed. The injection of Beck's bismuth paste into sinuses was also frequently employed. We will exclude discussion of the use of vaccines and bismuth as these substances evidently cannot alter the real influence of tuberculin.

At the outset it is well to establish a guide, some standard whereby we can gauge the results of treatment. We must decide what changes will indicate improvement or recession of the tuberculous process. The following changes would indicate improvement:

1. Disappearance of muscle spasm.
2. Disappearance or diminution of joint or bone sensitiveness.
3. Reduction of swelling.
4. Resorption of abscesses.
5. Healing of sinuses.

6. Healing of bone as shown by X-ray through
   A. Increased bone density
   B. Ankylosis
   C. Irregular outline of bone becomes regular.

The last is undoubtedly the most convincing proof of improvement. It is well again to emphasize that (1) improvement of the patient's general condition is not an evidence of the effectiveness of tuberculin, or that the tuberculous lesion is healing, for, general improvement is often obtained as above mentioned, by hygienic measures, forced feeding, sleeping in the open air, etc., and (2) Patients with tuberculous joints often look unusually well while the destructive process is advancing.

Report of Cases.

CHARLES W.—Four years old. (Dr. Whitman's Clinic.)

Tuberculous disease of the dorsal spine and right ankle. Duration of the disease when first seen was one and one-half years. Wears a plaster of Paris Jacket and a stiff ankle brace. Disease of the spine not progressing. Right ankle and leg markedly swollen; numerous sinuses; extensive destruction of the tibio-astragular point. Runs an afternoon temperature of 99.5°F. General condition fair; patient pale. Patient lives in the country under excellent hygienic surroundings. Tuberculin therapy begun April, 1916, with 10/100 cc of the third dilution. Tuberculin treatment continued, and completed June, 1918. Autogenous vaccine used. Sinuses injected with Bismuth paste.

Result: General condition unchanged; sinuses still discharging. Swelling of the ankle and leg just the same. Destruction of bone, as judged by numerous roentgenograms taken during the course of treatment, just as extensive. The tuberculin did no harm, but also caused no improvement or healing.

Result negative.

STELLA P.—Nine Years Old. (Dr. Gibney's Service.)

Entered Hospital for Ruptured and Crippled March 19, 1915, for tuberculous disease of the left hip complicated by several abscesses. Condition had been in existence for about one year. During June, 1915, another abscess developed and was evacuated. Tuberculin treatment was begun September 28, 1915. A full course

was given, that is, having begun with minute doses, these were increased so that finally in 1916 the patient was able to receive pure tuberculin as well as the bacillary emulsion without any reaction. In addition the patient received autogenous vaccines, and the sinuses, of which she had several, were injected with Bismuth paste. The patient had one reaction during the entire course of the treatment. When the patient was about half way along in the treatment, she developed another abscess. At the end of the treatment the patient had evidently not been improved, though at this time she was no worse. The local process in the hip was certainly not healed, as evidenced by the persistence of the clinical and X-ray findings. The abscesses and sinuses did not heal; in fact a new abscess appeared. Her general condition was slightly improved—but she had been kept in the open air most of the time and was receiving unusual care, and an extra amount of food. Subsequently, in April, 1917, her condition was somewhat worse; the discharge from the sinuses was more profuse than ever, and both the liver and spleen were palpably enlarged. This patient was certainly not helped by the tuberculin.

Result negative.

ISIDORE S.—Ten years old. (Dr. Gibney's Service.)

Tuberculous right hip. Several complicating sinuses. Flexion deformity of the hip. Tuberculin treatment began in the fall of 1915. A full course of treatment lasting over one year was given. In July, 1916, while he was getting tuberculin in the first dilution, he developed a fresh abscess. It is interesting to note that this patient like many others developed an abscess during treatment. When a patient has progressed from the third or fourth dilution to the first dilution, if the theory of the use of tuberculin is correct, the patient has developed a certain degree of immunity. Yet this boy developed an abscess while receiving the first dilution of tuberculin. In June, 1916, when he was getting pure tuberculin, he developed another abscess. Old sinuses re-opened in July, 1916.

Result: This patient was in no ways harmed by the tuberculin. Yet there was no improvement, for there was no sign of healing of the diseased hip, and the sinuses discharged as freely and as profusely as ever.

FRED K.—Nine years old.

Developed tuberculous disease of the left hip at the age of three years. The disease was progressive. At the time of my first examination on April 26, 1916, he was in good general condition. There was one inch of shortening of the left limb which was in an attitude of flexion, adduction and outward rotation. There were numerous scars about the hip from previous abscesses and sinuses, none of which were discharging. The X-ray picture showed destruction of the femoral head and marked excavation of the acetabulum.

Tuberculin treatment was begun May 17, 1916, with the injection of 0.1o cc of the third dilution and was completed January 13, 1917, having received a full course of tuberculin and bacillary emulsion. On five different occasions this patient gave a local and constitutional reaction to the tuberculin.

Two months after tuberculin treatment was begun, when he was receiving the second dilution, an abscess appeared on the front of the thigh; this left a sinus which discharged for about 15 months. At the end of the treatment the boy was in exactly the same condition as before the treatment except for the discharging sinus. X-ray pictures showed no increase of the destructive process. There was, however, no evidence of healing. The appearance of the abscess during the treatment may have been the result of the treatment—an exacerbation of the old focus, since theoretically tuberculin causes hyperaemia at the site of the disease. However, it is perfectly possible that this abscess might have appeared without the use of tuberculin. So that, giving the tuberculin the benefit of the doubt, the most that we can say for it in this particular case, is that it did no harm. It certainly did no good.

REUBEN R.—Twenty-one years old.

Came under my care February, 1916. He complained of pain and swelling of the left ankle. The diagnosis at first was in doubt because of a negative X-ray. Wasserman test was negative. A subcutaneous tuberculin test was positive as he developed local, constitutional and focal reactions. The focal reaction was the diagnostic feature; the ankle became more swollen, more painful and more sensitive. He was given a full course of tuberculin, including bacillary emulsion. At the completion of the tuberculin treatment the condition of the ankle was the same as that prior to the

tuberculin therapy, that is, the swelling, sensitiveness and limitation of motion of the ankle were the same. The disease continued until January 8, 1918, when I operated on the patient and removed the diseased tissue from the adjacent surfaces of the astragulus and os calcis.

This man came under my care six months after the apparent onset of the disease, so that this was an early case, and theoretically the right choice for tuberculin therapy. Yet even here the tuberculin was of no value, as the disease continued during and after a full course of tuberculin.

MR. S.—Fifty years old.

This patient was not under my personal supervision. I saw him in consultation and followed the course of his illness over a long period.

Extensive tuberculosis disease of one knee. The knee was deformed in flexion of about 90°. There were numerous sinuses about the joint, all discharging very profusely. This man was treated for many, many months with tuberculin and mixed vaccine without any benefit. Finally when the disease was extremely far advanced, and when the ulceration about the knee was so extensive that no kind of efficient support was possible, an excision was resorted to; later the limb was amputated and the patient died. In such a case it seems to me very much and valuable time was lost by adhering to tuberculin and conservative treatment, and neglecting operative treatment. During the months of conservative or rather expectant treatment, the deformity of the knee increased, the contraction of the tissues became more confirmed, and correction impossible. Moreover the secondary infection and ulcerations precluded successful operation. The time to have operated was as soon as the diagnosis of tuberculous arthritis was beyond doubt. This is the only method that offers a favorable prognosis.

In this case the tuberculin was evidently of no value. Moreover faith in its curing powers led to unnecessary delay and very poor judgment. It is in connection with such a case as this that we doubt the advice that tuberculin cures all cases of tuberculous bone and joint disease.

MORRIS F.—Twenty-one years old. Aug. 20, 1915.

This patient was seen one year ago with extensive disease of the left shoulder and abscess formation. He was advised an

excision of the diseased bone. Instead he received tuberculin treatment. The abscess was opened and is still discharging. The patient is in fair condition. He has had several acute exacerbations, but at present while there is some joint sensitiveness and muscle spasm, fair healing of the bone has evidently taken place. The boy is certainly not through with treatment—tuberculin or orthopaedic treatment. There can be no doubt that he is in better condition than he was a year ago; yet despite a full course of tuberculin, he is not done with treatment—nor will he be for some time to come. The question arises as to whether he would after all not have been better off with an operative removal of the focus, as there probably is a latent focus of tuberculous tissue in the apparently healed section of bone.

There is also this important question to answer: Could this patient perhaps have done just as well as he did with aspiration of the abscess, and ordinary fixation of the joint? He probably would have, and in addition the arm would have been supported in moderate abduction and been more useful than it is now, having been held at the side for one whole year.

BERNARD K.—Six years old.

I saw this patient for the first time on Dec. 9, 1917. He appears to me to be of special interest because the course of his disease leaves no room for doubt about the action of tuberculin. This patient developed tuberculous disease of the right hip joint. He consulted a prominent orthopaedic surgeon who diagnosed the condition, applied an efficient traction hip brace, and gave the boy a full course of tuberculin treatment including the bacillary emulsion. There is no doubt about the proper dosage, etc., of the tuberculin as this particular surgeon had made a special study of the administration of it and was acquainted with all its details. The boy came under observation in 1915. At that time he showed a beginning lesion in the femoral head. Numerous X-rays were taken at frequent intervals between 1915 and November, 1917, during which time he had completed his tuberculin treatment. The lesion gradually progressed, each successive X-ray showing increased bone destruction, and finally 1½ inches of shortening of the limb. The last X-ray shows marked erosion and enlargement of the acetabulum, marked erosion of the femoral head and depression of the femoral neck so that there is a pathological coxa

vara. Tuberculin was of no value whatever in this case for the destruction continued as if it had not been given at all.

AARON L.—Seven years old. (Author's Clinic, Lebanon Hospital)

Came under my observation in September, 1916. At this time he showed symptoms of irritation of the left hip joint and moderate flexion deformity. X-ray examination was negative. The deformity was corrected and the hip encased in a Plaster of Paris Spica. The sensitiveness of the hip continued, and in June, 1917, an X-ray picture showed slight erosion and enlargement of the acetabulum and slight rarefaction of the head and neck of the femur. Wasserman test was negative. A subcutaneous tuberculin test was positive. There was no source or focus of infection discoverable of which the hip involvement might be a secondary or metastatic lesion. The clinical and X-ray findings plus the positive tuberculin test made the diagnosis of tuberculous hip undoubted. The boy was given a full course of tuberculin and bacillary emulsion. At the end of this time, in April, 1918, another X-ray examination was made of the hip. This picture showed complete destruction of the head of the femur, partial destruction of the neck, and an upward displacement of the great trochanter. In this, as in the last case the conclusion is evident. Destruction of bone continued despite the use of tuberculin—an evident tuberculin failure.

MAGGIE F. (Services of Drs. Gibney and Whitman). Ten years old.

Entered Hospital for Ruptured and Crippled on Aug. 24, 1914. Developed tuberculosis of the spine and left hip 1½ years previously. Examination by Dr. Whitman on Aug. 27, 1914, showed active disease of the spine (11 and 12 dorsal) and left hip, and disease of both elbows apparently in a quiescent or latent stage. Between August, 1914, and September, 1915, patient developed numerous abscesses about the left hip; these ruptured spontaneously or were opened and continued to drain. There were also several sinuses about the elbows. The patient gradually improved so that on Sept. 23, 1915, the general condition was good. The sinuses about the elbows were all healed. There were, however, several sinuses about the left hip. The patient was running a slight temperature and the impression one gained was that this was the kind of a case in which it was difficult to predict the likely course; she might go on to further improvement, or might get very much

worse. The spine and three large joints were involved, the patient was running a temperature, and altogether it was exactly the type of patient for whom we needed additional help. This patient was an Italian, and having been warned by Dr. Bonime that in Italians and Negroes we must begin with small doses of tuberculin, this patient was started on the 5th dilution of tuberculin on Sept. 28, 1915. On Dec. 2, 1915, it was noted that patient had thus far tolerated the tuberculin well. She was in fair condition. There were no sinuses about the elbows and only two sinuses about the hip. It might here be mentioned that this patient, like all others, was receiving an extra amount of food, was kept on the porch all day long, and in other ways received an extra amount of attention.

On Jan. 6, 1916, this patient received 0.40 cc of the third dilution of tuberculin, this being the proper dose at this time. She developed a temperature of 104 and malaise. There was a local reaction. The left elbow became markedly swollen and acutely inflamed. A great amount of pus developed, and this had to be liberated on both the inner and outer sides of the elbow joints, leaving two sinuses which continued to discharge. Soon afterwards she developed an iritis in the right eye, and the discharge from the sinuses about the left hip became profuse. Her general condition became very poor. I resorted to the use of autogenous vaccine, employed bismuth paste, reduced the dosage of tuberculin very materially, but could not induce any favorable change. The patient continued on the down grade. In August, 1916, the patient, in spite of extra attention and a stay in the country, was evidently worse. The sinuses were discharging very profusely. The liver and spleen were much enlarged and the patient looked very poorly. She then disappeared from observation, and some months later I heard that she had died.

In reviewing this case we are forced to conclude that tuberculin was mainly, if not entirely, responsible for the aggravation of the condition. It may be argued that this was an unfavorable case; but we have no means of judging which is and which is not an appropriate case for tuberculin treatment. Every dose of tuberculin causes a focal reaction—that is, an acute aggravation of the tuberculous lesion. Under ordinary circumstances this reaction is mild and causes no harm. But in the hyper sensitive

individual this reaction may, as it did in this instance, cause an uncontrollably severe exaccerbation leading to disastrous results.

The treatment in this case might not have resulted so poorly, had it been possible to always keep within the limit of the patient's tolerance. It is however impossible to always avoid a constitutional and focal reaction. In fact Dr. Bonime states (p. 53) that "The only index to the measure of tolerance in every individual is a constitutional reaction, hence a constitutional reaction is desirable in every case."

Dr. Bonime recognises the occasional occurrence of very severe reactions, for he states that "Only long experience and expert judgment can bring about a fair amount of accuracy in the choice of the patient—a fact that stands out most prominently against the wider adoption of tuberculin therapy." In this case, then, the tuberculin aggravated the disease.

DOMINICK M.—Nine years old. (Services of Drs. Gibney and Whitman).

Patient was seen by me in August, 1915. He had tuberculous disease of the right hip joint with numerous sinuses. He entered the hospital in May, 1915, in very poor condition. Examination shows that the boy had very extensive destruction of the right hip joint. There were numerous sinuses and ulcers extending along the right thigh so that the entire thigh was an open wound from the hip to the knee. There was a very profuse discharge of foul smelling pus. The patient was pale, very weak and helpless. He lay in a wheel cart, the affected limb being so sensitive that he was unable to bear any weight on it, or permit any manipulation. He ran a daily temperature ranging from about 100 or 101° in the morning to 103 or 104° in the afternoon. He was given tuberculin, autogenous vaccine and the sinuses were injected with a mixture of Zinc Oxide, Balsam of Peru and Vaseline. This boy improved slowly, but very markedly. His temperature subsided entirely; most of the sinuses closed up, and the sensitiveness of the joint diminished. In December, 1916, this boy was in good condition. His temperature was normal, he had gained in weight, his appetite was good, and he looked bright. There were only a few sinuses about the hip discharging a moderate amount of pus, and he was walking about. This is the only case in my experience which showed so remarkable a change. But even in this case it

is impossible to say that the tuberculin alone was responsible for the improvement, since we used an autogenous vaccine.

MARY S.—Ten years old. (Dr. Whitman's Service.)

Tuberculous right ankle; no sinuses. September, 1915. Ankle is swollen and painful. Leg and foot encased in plaster. Patient uses crutches. Tuberculin treatment began Sept. 25, 1915, with 0.10 cc of the IV dilution. Treatment completed June, 1916. She improved gradually so that she was able to discard crutches and plaster. The sensitiveness of the joint disappeared and the function of the ankle improved considerably. This patient was evidently benefited by the tuberculin. Six months after completion of the tuberculin therapy, the patient suffered a relapse. There have been several relapses—temporary swelling and sensitiveness of the ankle—during the last two years. We may say of this case that tuberculin was apparently helpful, the disease retrogressed, the patient was improved generally, but the disease was not cured as there have been relapses.

HENRY S.—Seven years old. (Dr. Whitman's Service.)

Tuberculous left elbow. Has had the disease for about two years. There are several discharging sinuses about the elbow. X-ray taken May 5, 1915, shows marked involvement of the ulna. Tuberculin treatment was begun October 14, 1914, with 0.10 of IV dilution. The patient received a full course of Old Tuberculin and Bacillary Emulsion. He received the last dose of the latter preparation November 18, 1916. In addition he received an autogenous vaccine of staphy-lococcus albus. He had several mild reactions. This patient improved definitely. The sinuses healed; the joint sensitiveness diminished materially; there appeared returning motion in the joint, and an X-ray taken July 18, 1917, showed increased bone formation in the area previously softened by disease. Improvement was evident in this case, and although it was not particularly severe to begin with, nevertheless the change was prompt and definite, and we must attribute the good result to the tuberculin. This patient continued in good condition for some time. He was seen again on May 2, 1919, and the joint was found swollen and painful—that is, he had a relapse.

I have used tuberculin in at least eight or ten cases more. These are not reported in detail because none of them received a

full course of treatment. This much, however, must be said, that there was apparently no benefit derived from its use.

Discussion

Curability of Bone and Joint Tuberculosis by Tuberculin.

The most important and evident conclusion from a study of our cases is that none were cured by the administration of tuberculin. Only three cases of the entire series were improved; two of these later developed a relapse. One case was manifestly aggravated. In all the others the result was negative, we could see no influence of the tuberculin for better or worse. I desire to emphasize the fact that this conclusion is all the more important, because it agrees entirely with the results of my observation in a much larger number of cases seen at the Polyclinic Hospital. I have myself treated very many more than are here reported, both at the Hospital for Ruptured and Crippled, and at the Lebanon Hospital, but I do not report them because treatment for one reason or another was not completed.

Many observers believe that tuberculin is a tonic for tuberculous individuals. Perhaps that is so. Even in our series we cannot deny that even in the negative cases tuberculin may have acted as a tonic or stimulant. If it did, its influence was not evident, and certainly inconsequental. General improvement, evidence of supposed tonic influence, is, however, more than likely due to unusual care these patients receive.

Our experience differs from that of Dr. Bonime, who in speaking of the use of tuberculin in bone and joint cases says "I cannot recall a single case in a period of seven years that has proven an out-and-out failure." In reading Bonime's book on tuberculin therapy, one gets the impression that tuberculosis need no longer be feared, and that the tuberculous can all be cured by the use of tuberculin. From a fairly extensive experience with my own cases and many others, I cannot recall a single case of an out-and-out success.

And as a matter of fact when we analyse the nature of tuberculin, and study its pharmacology, we do not expect that it should *cure* tuberculosis. It is pretty well agreed upon that tuberculin is a solution containing *some* of the toxins of the tubercle bacilli, and

certainly *not all* of the toxins. At best, therefore, as emphasized by Klotz, tuberculin can produce a tolerance to only a limited variety of the tuberculous toxins. Tuberculin produces a tolerance for tuberculin, and not for the tubercle bacilli or all of their toxins. So that when a patient has been brought to a point where he can assimilate tuberculin without re-action, he is not cured, he is not immunized against tuberculous infection, he has simply acquired a tolerance for certain of the by-products or toxins of the tubercle bacilli.

It is conceivable that in a limited number of cases the toxins producing the disease are identical with those contained in the tuberculin, and such cases may actually be cured by the use of tuberculin. Such cases must be rare and are accidental, and as we have no means of knowing the exact toxins contained in the tuberculin, selection of cases is impossible. In those cases in which tonic effect and improvement were noted, it may be that the tuberculin acted by immunizing against certain of the toxins of the disease, and in that way was useful. But in the majority of cases it certainly does not immunize against enough of the toxins to act as a cure. Shively concludes from his experience that in selected cases tuberculin has a stimulating effect, but that "tuberculin in itself has no curative properties."

In his book on Tuberculin, Bonime teaches that a patient is cured of his disease when he can tolerate pure tuberculin. This is suggested in the following remark "and lastly, but not the least, is the fact that in the case of a patient cured by tuberculin, the orthopædist will be able to decide the exact time for the removal of the various appliances." He evidently assumes in this sentence as in many others in his book, that when a patient can take pure tuberculin without re-action, he is cured. This is a fallacious assumption as proven by my own cases, many of which were brought to a point of taking pure tuberculin without re-action, but in whom the disease was either continuing in its chronic course, or was progressing.

My experience in this regard is borne out by Trudeau and Klotz. The former observer states "It cannot be said, that the amount of good a patient derives from tuberculin treatment is always in direct ratio to the size of the dose of toxin he can be brought to tolerate." Klotz states that "Tuberculin cannot and

does not confer immunity against infection with tubercle bacilli either as a preventative measure or in the course of disease."

That tuberculin does not immunize against the destructive influence of the disease is shown especially in two of my cases, F. K. and A. L. These boys had closed lesions. They were brought to a point where each was able to take pure tuberculin subcutaneously without re-action. Yet, despite the supposed immunization, the disease progressed and the bone destruction continued.

The disappearance of an abscess does not in itself decide the cure of the underlying disease. On the other hand, the development of an abscess during the administration of tuberculin, and especially when the patient is taking almost pure tuberculin, certainly indicates that tuberculin does not develop immunity or cure. Several of my cases developed abscesses some time after the tuberculin therapy was going on, and while the patient was tolerating number two or even number one dilution of tuberculin.

There is another phase of tuberculin therapy that must not be overlooked. This may be divided into the immediate and remote effects. Among the immediate effects must be considered the toxic influence on the patient and the disease. There is no doubt that tuberculin is a poison and an overdose may be very disastrous. Klotz states "The essential effect of tuberculin is the focal re-action or the inflammatory changes that take place in or about all existing tuberculous foci." "These changes consist in congestion or, if severe enough, necrosis and softening." A large dose may cause extension of the tuberculous process. Trudeau states "Clinical experience has pretty definitely established by this time that marked re-actions, whether general or focal, are not beneficial, and may be dangerous by their baneful effect on the general condition of the patient and also by producing aggravation and extension of the local lesion." M. S. Cohen states that a dose in excess of the exact amount required frequently proves disastrous, and has even hastened death. Baldwin states that while tuberculin may do some good that "It may aggravate the disease." In one of my cases the disease was very distinctly made worse, and the patient ultimately died. Thus tuberculin may prove very harmful, and its administration must be accompanied by careful, close, and continuous observation.

Remote effects: Among these must be considered the results of the combination of over confidence in the value of tuberculin,

and oversight of the usual orthopaedic treatment. Such ill results were shown in two of our cases. One was the adult with tuberculosis of the shoulder. Inefficient splinting resulted in ankylosis of the shoulder with the arm at the side of the chest—a poor functional result, a condition which could have been avoided by efficient splinting. The other was the case of the adult with tuberculosis of the knee. So much faith was placed in the value of tuberculin that support of the knee was neglected, with the result that the knee became contracted to 90 degrees. Secondly, so much time was wasted with the tuberculin, that the opportunity of cure by excision of the knee joint and the diseased tissue was lost.

I would further call attention to the fact that inasmuch as the ability of the patient to tolerate pure tuberculin does not indicate a cure, removal of an appliance is not necessarily indicated when tolerance for tuberculin has been established. Speaking of the removal of apparatus, Bonime says that "This necessarily always had to be a matter of guess, as the orthopaedist was never certain whether the joint is merely quiescent or cured, and therefore frequently insisted on prolonging the wearing of these appliances for a number of years, even though the patient seemed entirely well. With the danger of a relighting of the infection removed—the element of guess is eliminated—and both the patient and the orthopaedist need not fear the removal of the appliances." The same author continues: "The tuberculin will, moreover, act as a guide to the limitation of orthopaedic treatment—it will be unnecessary to order the cumbersome appliances to be worn year after year, for tuberculin will do away with the element of "guess," which has to be so prominent in orthopaedics. For with the conviction of having checked the infection and overcome the susceptibility, the length of time for orthopaedic application can be gauged more accurately.

Firstly the orthopaedist is not quite in such a desperate circumstance that he must "guess" about his treatment. Secondly, when a tuberculous individual can take pure tuberculin, that does not mean cure of the joint; it does not mean that the tuberculous infection has been checked—and such an assumption would be frequently hazardous and disastrous to the joint.

It would be well if we knew when the danger of a relighting of the infection was removed. It certainly is not removed when the patient has been brought to the point where he takes pure

tuberculin, for we know that relapses do occur after full tolerance for tuberculin has been established. To follow Bonime's advice would work great mischief. If a splint is removed just because pure tuberculin is tolerated, and without proper regard for the condition of the affected joint and limb, other possible ill effects, such as increased bone destruction, increase of deformity, aggravation of symptoms, etc., may be imagined.

Conclusions

1. Tuberculin does not cure tuberculosis of bones and joints.

2. In the majority of cases, tuberculin therapy causes no noticeable beneficial influence over the bone or joint lesion.

3. In a small percent of the cases there is improvement of the lesion.

4. In some cases there may be distinct aggravation of the disease.

5. New abscesses may appear during and after completion of the tuberculin treatment.

6. Relapses occur after apparent improvement.

References

Baldwin, E. R. ..... N. Y. State Jnl. Medicine, Oct., 1913.
Trans 7th Annual Meeting of the National Assn. for the Study and Prevention of Tuberculosis.
Yale Med. Jnl., Feb., 1909.
Barnes, H. L. ..... Journal of Amer. Med. Assn., Aug. 3, 1912.
Bonime, Ellis ..... Tuberculin and Vaccine in Tubercular Affections.
Brown, L. ..... Boston M. & S. Jnl., July 23, 1908.
Cohen, M. Solis ..... Journal of Amer. Med. Assn., Oct. 7, 1914.
N. Y. Medical Journal, Aug. 9, 1913.
Cohen & Strickler ..... New York Med. Jnl., Jan. 13, 1912.
Deal, F. A. ..... Medical Record, Nov. 26, 1910.
Duke, W. W. ..... Jnl. Miss. State Med. Assn., January, 1914.
Francine and Hartz .. Journal of Amer. Med. Assn., March 8, 1913.
Fremont-Smith, F. .... Medical Record, Oct. 17, 1891.
Klotz, W. C. ..... Cal. State Jnl. of Medicine, July, 1916.
Lyon, J. A. ..... Boston M. & S. Jnl., Aug. 1, 1912.
Nutt & Hastings ..... Amer. Jnl. Orth. Surgery, Aug., 1908.
Ogilvy, Charles ..... Amer. Jnl. Orth. Surgery, Aug., 1908.
Paterson, R. C. ..... Can. Med. Assn. Jnl., May, 1918.
Pogue, W. R. ..... Medical Record, Aug. 4, 1906.
Pottenger, F. M. ..... Therapeutic Gazette, March, 1903.
Ruck, Karl von ..... Medical Record, Sept. 7, 1907.
Shively, H. L. ..... N. Y. Med. Jnl., Jan. 8, 1916.
Trudeau, E. L. ..... British Jnl. of Tuberculosis.
Jnl. Amer. Med. Assn., Jan. 23, 1907.

DISABILITY FOLLOWING INJURIES TO THE BACK IN INDUSTRIAL ACCIDENTS

BY JAMES WARREN SEVER, M. D., OF BOSTON, MASS.

Presented at the Annual Meeting of the American Orthopdaeic Association, Atlantic City, June, 1919

(Continued from November Journal)

CLASS I.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability	Diagnosis	Treatment
M	55	Plasterer	Fell 27 ft.	3 months	Back contusion; question of arthritis	Adequate.
M	38	Teamster	Thrown from team	6 months still disabled	Contusion and back strain	Inadequate.
M	38	Roofer	Fell 35 ft.	8 months still disabled	Contusion back	Inadequate.
M	?	Laborer	Fell 4 ft.	1 month	Contusion back	Inadequate.
M	46	Laborer	Fell on back	1 month	Contusion back	Inadequate—Returned to work after accident; has no trouble with back. Makes larger wages, and has worn no apparatus.
M	23	Laborer	Fell 10 ft.	6 months still disabled	Contusion back	Inadequate.
F	35	Chambermaid	Fell down stairs	3 months	Contusion back	Inadequate—No work since accident July, 1916, to February, 1918; still has backache.
M	24	Laborer	Fell 24 ft.	6 months	Contusion	Adequate.
M	40	Laborer	Fell 18 ft.	8 months	Fractured astragalus Contusion back	Inadequate—February 13, 1918, three years after accident still backache and trouble with foot. Still unable to work.
M	21	Carpenter	Fell 18 ft.	3 months	Contusion back	Inadequate.
M	41	Laborer	Fell 6 ft.	1 month	Back strain	Inadequate—Still incapacitated.
M	40	Laborer	Fell 60 ft.	6 months	Contusion back; fractured right leg left knee	Adequate—Still incapacitated.
M	54	Laborer	Fell 3 ft.	3 months	Arthritic spine; contusion back	Inadequate—Still incapacitated.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
F	50	Shoemaker	Fell 7 ft.	7 months	Contusion back	Inadequate—Still partially incapacitated.
M	34	Laborer	Fell 4 ft.	1 month	Contusion back	Inadequate—No disability
M	39	Carpenter	Fell 10 ft.	28 months	Contusion back	Adequate—No disability.
M	46	Laborer	Fell 10 ft.	4 months	Contusion back	Inadequate—Still partially incapacitated.
M	42	Teamster	Fell 6 ft.	13 months	Spondylolisthesis	Adequate—Still disabled.
M	52	Laborer	Fell 18 ft.	1 month	Contusion back; arthritis	Adequate—Still disabled from arthritis.
F	36	Factory	Fell 3 ft.	1 month	Contusion back	Adequate—No disability.
F	30	None	Fell 3 ft.	2 months	Contusion back	Adequate—No disability.
F	35	Factory	Fell 3 ft.	5 months	Contusion back	Adequate—No disability; back at work.
F	21	Factory	Fell down stairs	3 months	Contusion back	Adequate—No disability.
M	28	Laborer	Fell 10 ft.	26 months	Arthritis; contusion back	Adequate—Still disabled—arthritis.
M	23	Laborer	Fell 12 ft.	1 month	Contusion back	Adequate—Well.
M	70	Carpenter	Fell 12 ft.	6 months	Arthritis; contusion back	Inadequate—Still disabled—Hypertrophic arthritis.
M	38	Laborer	Fell 20 ft.	32 months	Contusion and back strain	None—Been working off and on. Back still a cause of disability.
M	37	Laborer	Fell 6 ft.	1 month	Contusion	Adequate.
M	40	Laborer	Fell 3 ft.	2 months	Contusion	Inadequate—No longer disabled.
M	30	Laborer	Fell 30 ft.	3 months	Contusion	None—No longer disabled.
M	30	Painter	Fell 38 ft.	1 month	Contusion back. Broken ribs	Adequate—Still slightly disabled.
M	47	Baker	Fell 16 ft.	4 months	Contusion back	Adequate—No disability.
M	46	Painter	Fell 6 ft.	8 months	Cardio-renal; contusion back	Adequate—Still disabled but not on account of accident.
M	48	Laborer	Fell 8 ft.	6 months	Contusion back	Inadequate—Still disabled.
F	38	Factory	Fell 10 ft.	7 months	Contusion back	Adequate—No disability.
F	42	Factory	Fell in elevator 5 ft.	3 months	Back strain	Inadequate—Still disabled.
F	41	Barber	Fell 3 ft.	13 months	Back strain	Inadequate—Still partially disabled with backache.

Average Period of Disability in this series 6.3 months.

37 cases { Treatment: { Adequate 17—average period of disability 6.8 months
Inadequate 18—average period of disability 4.5 months
None 2—average period of disability 17+ months

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	55	Painter	Fell 22 ft.	18 months	Fractured odontoid Fractured wrist	Inadequate—Never wore apparatus. Still disabled, and a stiff neck. Bed for 7 weeks.
M	52	Rigger	Fell 15 ft.	40 months	Fractured 12th dorsal and 1st lumbar. Fractured shoulder	Practically none—Had on frame about 6 weeks, since then none. Still disabled.
M	40	Roofer	Fell 25 ft.	16 months	Partial dislocation. Question of arthritis	Adequate—Stiff neck. Partially disabled.
M	40	Laborer	Fell 15 ft.	17 months	1st and 2nd lumbar vertebra. Fractured wrist	Adequate—Still partially permanently disabled. Wears a back brace.
M	48	Carpenter	Fell 45 ft.	5 months	Fractured 1st and 4th lumbar	None at first—One year later gave up brace and went to work. Diagnosis not made for 5 months.
M	43	Carpenter	Fell 30 ft.	5 months	Fractured wrist and 1st lumbar	None—After four weeks, condition of back was diagnosed and treated. Still disabled.
M	28	Laborer	Fell 27 ft.	4 months	Fractured ankle, lamina and 1st lumbar	None for back—Kyphos. Back weak but incapacitated because of foot condition.
M	22	Electrician	Fell 40 ft.	8 months	Fractured spine; crush cord. Fractured left leg	Wore a jacket 6 weeks—no further treatment.
M	44	Mason	Fell 50 ft.	7 months	Fractured 9th Dorsal; 11th, 12th Dorsal, and 1st lumbar	Adequate—Permanent disability. Partial paralysis of legs.
M	30	Laborer	Fell 53 ft.	14 months	Fractured ankle, 2nd lumbar	Adequate—Wearing leather jacket. No paralysis. Partial disability.
M	44	Butcher	Fell 15 ft.	39 months	Fractured 2nd and 3rd lumbar	None—Back strapped for 5 weeks—Kyphos. Has had no treatment. Partially disabled. Does light work on a farm.
M	40	Roofer	Fell 30 ft.	10 months 24 months	Fractured 1st lumbar Fractured wrist	None—No X-ray of back for 10 months. No treatment for back. Has worn no apparatus. Partially disabled.
M	45	Laborer	Fell 40 ft.	9 months	Fractured 1st lumbar	Inadequate—Fracture not recognized. Getting osteopathy for a lame back.
M	45	Iron worker	Fell 33 ft.	2 months	Fractured 12th dorsal	None—Back strapped once—Kyphos. Partially disabled.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	56	Laborer	Fell 15 ft.	15 months	Fractured 3rd lumbar	None—In a Hospital after accident and back strapped. Massage and exercises since.
M	38	Plasterer	Fell 40 ft.	14 months	Fractured 12th dorsal, 1st lumbar	None—In bed in a Hospital 30 days. Has done no work. Still has pain in back.
M	42	Plasterer	Fell 10 ft.	5 months	Fractured 1st lumbar	None—In bed at home 7 weeks; been working off and on. Back occasionally lame; wears no brace.
M	39	Plasterer	Fell 12 ft.	12 months	Fractured 12th dorsal and 1st lumbar	Adequate—Jacket and back brace. Still unable to work—Kyphos.
M	42	Laborer	Fell 25 ft.	16 months	Fractured 2nd cervical	Adequate—Stiff neck. Traumatic neurosis. Thinks he is unable to work.
M	39	Laborer	Fell 17 ft.	18 months	Fractured first lumbar	Adequate—Kyphos—no work since accident. Constant backache. Wears a back brace.
M	18	Laborer	Fell 20 ft.	37 months	Fractured 11th and 12th dorsal, 1st and 2nd lumbar	Adequate—No arthritis symptoms; wearing back brace; has had jacket. Still partially disabled.
M	53	Teamster	Fell 15 ft.	32 months	Fractured 1st lumbar. Hypertrophic arthritis	Inadequate—Kyphos. Marked arthritis of spine. No work since accident. Wearing a 6-inch belt.
M	33	Laborer	Fell 54½ ft.	53 months	Fractured 11th dorsal	Inadequate—No cast until 2 years after accident. Kyphos. Still disabled except for light work.
M	31	Laborer	Fell 70 ft.	14 months	Fractured 2nd and 3rd lumbar. Fractured leg	None—Went home from Hospital with leg in a cast. Nothing done for back until the end of a year. Now wears a back brace. Permanent disability.

Whole of Class I — Treatment:

- Adequate — 25—average period of disability 9.8 months.
- Inadequate — 23—average period of disability 8 months+
- None — 13—average period of disability 15 months+

52 males.
9 females
Average age 40+.
Average time after accident when seen by Impartial Examiner, 11 months—minimum period of disability.

CLASS II.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	45	Laborer	Bale of hay fell on back	5 months	Contusion back	None—Has had no treatment. Still disabled partially. Traumatic hysteria.
M	16	Laborer	Ladder fell across back	1 month	Contusion back	None—No longer disabled.
M	42	Laborer	Concrete roof fell on him	2 months	Contusion back	None—Rest in bed. No disability.
M	38	Teamster	Struck by box	2 months	Contusion back	None—In bed two weeks at home. No other treatment. No disability.
M	27	Teamster	Struck by coal screen	1 month	Contusion back	Inadequate—Strapped twice. No further treatment. No disability.
M	61	Laborer	Struck by paving stone	8 months	Contusion back	Inadequate—Massage and baking for a month. Not disabled.
M	47	Laborer	Struck on back by dirt	4 months	Contusion back	None—Traumatic hysteria. Not disabled.
M	40	Carpenter	Struck by timber	1 month	Contusion back	None—Tender in sacro-iliac region. Still partially incapacitated.
M	16	Teamster	Struck by wheel hub	1 month	Contusion back Question of hernia	Inadequate—Sticking plaster. Went to work in three weeks. Had a large double hernia preexistent to accident.
M	73	Steamfitter	Steampipe fell on back	36 months	Contusion back. Arthritis	None—no work since accident. Arthritis preexistent. Senile.
M	43	Laborer	Trench caved in on him	7 months	Contusion and back strain	Adequate—Bed three weeks and jackets. No bony injury. Strapped once. Traumatic hysteria at present. Condition at present postural and mental. Having no treatment.
M	23	Laborer	Trench caved in on him	3 months	Contusion back	None—No longer disabled. Not at work.
M	54	Teamster	Kicked by horse	3 months	Contusion back	None—Has done no work. "No strength in back." Not disabled.
M	55	Laborer	Bag of cement fell on back	2 months	Contusion back	Adequate—Bed three weeks, liniment, strapping. Well, not disabled.
M	39	Laborer	Struck by falling concrete	16 months	Contusion back	None—After accident arrested and in jail hospital ten months. Still disabled.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	42	Laborer	Struck back against wall	16 months	Contusion back	Practically none—Liniment and strapping. At work in ten days. Still complains of stitch in back.
F	21	Factory	Machine struck back	7 months	Contusion back	Inadequate—In bed a week. Occasional strapping. Still has backache. Partially incapacitated.
M	55	Laborer	Struck by hand truck	5 months	Contusion back. Arthritis	None—Disabled, but due to Hypertrophic arthritis.
M	34	Laborer	Steam hammer hit back	3 months	Contusion back	Inadequate—Liniment at first, later strapped and a belt. Still partially disabled.
M	45	Chauffeur	Struck by auto seat	4 months	Sprain of back	Adequate—no present disability.
M	29	Laborer	Load of dirt fell on back	1 month	Contusion back.	Inadequate—Well, not incapacitated.
M	48	Laborer	Kicked by horse. Immersion	3 months	Contusion back. Fractured collar bone	Inadequate—In bed two weeks. Back at work on streets.
M	46	Longshoreman	Crushed by bags of sugar	7 months	Contusion back	Inadequate—Traumatic neurosis. Not disabled.
M	28	Laborer	Struck by paper bailer	3 months	Contusion back	None—Not disabled; disinclined to work.

FRACTURED SPINES

M	29	Truckman	Bag of flour fell on back	8 months	Fractured 1st lumbar	Inadequate—Back strapped; in bed 17 days. Jacket for 1 month. No treatment since. Kyphos-permanent partial disability.
M	31	Laborer	Struck by falling timber	36 months	Fractured 1st and 2nd lumbar	None—Diagnosed as tubercular spine. Kyphos; now wearing a corset. Partially disabled.
M	62	Teamster	Jammed between wagon seat and electric shovel	24 months	Fractured 5th lumbar. Pedicle	None—Furnished with a belt after a year. No medical attention. Partial disability.
M	30	Laborer	Wooden staging fell on him	1 month	Fractured 1st sacral lamina	None—Hospital four days. No other treatment. Went back to work two months later at increased wages, but still has occasional pain in back.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	51	Laborer	Back forcibly flexed	43 months	Fractured 1st lumbar	Inadequate—Kyphos. Fracture went untreated and unrecognized for a long time. Still partially incapacitated.
M	39	Laborer	Struck by derrick block	6 months	Fractured 6th cervical vertebra	Inadequate—Neck now normal. No disability.
M	48	Teamster	Run over by wagon	2 months	Fractured 4th transverse processes of 4 lumbar vertebrae	Inadequate—Ruptured kidney; bed eight weeks. No further treatment. Still disabled.

Treatment:
- Adequate 3—average period of disability when seen 3 months+
- Inadequate 12—average period of disability when seen 7.5 months
- None 16—average period of disability when seen 9.8 months

Average time after accident when seen by Impartial Examiner—8 months+.
30 males.
1 female.
Average age—40 years+.

CLASS III.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	43	Laborer	Pushing a truck	2 months	Back strain	Inadequate—Back strapped after 2 weeks. Felt something snap in back. Partially incapacitated.
M	53	Baker	Slipped	5 months	Back strain	Inadequate—Occasional strapping and later occasional massage. No disability.
M	27	Laborer	Lifting piece of concrete	12 months	Back strain; question of muscle tear	Adequate—Felt something give way in back. Strapped; jacket, belt, and brace. No disability.
M	55	Laborer	Lifting a lathe	3 months	Back strain; question of muscle tear	Adequate—Legs gave out. Strapped; cast and back brace. Partially incapacitated.
M	25	Machinist	Twisting strain	20 months	Back strain	Adequate—Probable malingerer. No evidence of injury at present.
M	54	Carpenter	Lifting heavy lumber	52 months	Back strain; arthritis	Adequate—No work since in July. No pain in back for one year after accident. Disability due to arthritis.
M	42	Pressman	Lifting 200 lbs.	3 months	Back strain; question of muscle tear	Adequate—Hospital two weeks. Strapped: jacket and belt. No present disability.
M	40	Fireman	Shoveling coal	9 months	Back strain+	None—went to work 6 months after accident firing a furnace. No disability.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	54	Boat-builder	Lifting lumber	1 month	Back strain+	Inadequate—Bed 3 days; liniment. No longer disabled.
M	39	Laborer	Lifting a stone	4 months	Back strain+	Inadequate—Not disabled; mental.
M	42	Laborer	Lifting a water pipe	8 months	Back strain+	Inadequate—Pain in back ever since accident. Strapping and belt (6 inch). Still disabled.
M	43	Teamster	Lifting heavy load, 400 pounds	8 months	Back strain+; question of sacro-iliac	Inadequate—Felt snap in back. Strapped; loose belt. Still disabled.
M	29	Steamfitter	Holding heavy weight	4 months	Back strain+	None—Felt something give in back; could not straighten up. Porous plasters, etc. Partially disabled.
M	29	Laborer	Lifting iron	1 month	Back strain	Inadequate—One strapping a week after accident. Still disabled.
M	43	Steamfitter	Carrying a radiator	3 months	Back strain	None—Felt something snap. Rest in bed a week; has tried to work. Still disabled.
M	42	Janitor	Lifting ashes	1 month	Back strain	None—Still partially disabled.
M	34	Carpenter	Lifting iron beam	10 months	Back strain	Adequate—Strapping, cast and belt. No longer incapacitated.
M	46	Iron moulder	Lifting pattern case	13 months	Back strain	Adequate—Bed 2 months; then cast and back brace. Been at work since 4 months after accident. Not disabled.
M	49	Carpenter	Lifting wooden blocks	1 month	Back strain; contusion	Inadequate—Strapped once. Still partially disabled.
M	15	Laborer	Lifting a barrel	2 months	Scoliosis	None—Had no injury, but did have bad structural scoliosis. No disability.
M	31	Shipper	Lifting heavy material	4 months	Back strain; question of sacro-iliac	Inadequate—Stooping over; felt something give. No work since accident. Strapped and a belt later.
M	35	Laborer	Sudden pull on back muscles	4 months	Back strain; question of tear	None—Occasional strapping. No work. Partially incapacitated.
M	41	Laborer	Lifting a sand scoop	1 month	Back strain	Inadequate—Strapped once. Hospital 6 days. Partially incapacitated.
M	?	Laborer	Lifting a barrel	4 months	Back strain	None—No disability.
M	30	Grocery clerk	Lifting box	1 month	Back strain	Inadequate—Something gave way. Strapped for 3 weeks. No disability.
M	80	Janitor	Slipped and strained back	6 months	Back strain	None—No work since accident. Still partially incapacitated.
M	30	Laborer	Lifting a barrel	3 months	Back strain	Inadequate—No work since; one strapping. Still incapacitated.

Sex	Age	Work	Injury	Time after accident seen by Impartial Examiner. Minimum period of disability.	Diagnosis	Treatment
M	39	Laborer	Lifting a box of steel	24 months	Back strain; question of Hypertrophic arthritis	Adequate—Had arthritis of spine which was cause of disability. No work since accident.
M	32	Carpenter	Lifting concrete	9 months	Back strain	Inadequate—Pills and iodine. Working since 4 months after accident at previous occupation.
M	44	Carpenter	Lifting timber	2 months	Back strain	Adequate—Wore a belt part of the time; back at work. No disability.
M	62	Laborer	Lifting strain	1 month	Back strain	Inadequate—Strapped several times. Still partially disabled. Age a factor.
M	33	Teamster	Lifting coal	3 months	Back strain	Inadequate—No doctor for three weeks. Strapped once Some work off and on. Really laid up only 7 weeks. No disability.
M	39	Laborer	Lifting stove	4 months	Back strain; question of sacro-iliac	Inadequate—Strapped twice. Went to work 16 months after accident.
M	43	Teamster	Lifting bag of potatoes	4 months	Back strain	Adequate—Jacket; went to work 3 months after accident. Still pain in back. No disability.
M	24	Electrician	Lifting timber	13 months	Back strain	Adequate—Frame treatment. Back brace. No longer incapacitated.
M	29	Laborer	Lifting a railroad tie	3 months	Back strain	None—Bed at home 2 weeks. No disability.
M	46	Grocery clerk	Stepped off wagon	5 months	Back strain	Inadequate—Went to work 10 months after accident. Wears a belt occasionally. No further disability.
M	39	Longshoreman	Lifted bar of steel	1 month	Back strain	Inadequate—Liniment and occasional strapping. Still incapacitated.
M	50	Wheelwright	Wrenched back	14 months	Back strain	Adequate—Wears a leather jacket. Still incapacitated.
M	34	Candy cook	Lifting tub of syrup	5 months	Back strain	None—No disability. Has worked off now.
M	42	Laborer	Lifting timber	1 month	Back strain	Inadequate—Liniment; occasional strapping. Still disabled.
M	35	Laborer	Shoveling dirt	2 months	Back strain	Inadequate—Occasional strapping. Still partially disabled.

Treatment:
- Adequate 12—average period of disability when seen 14.1 months
- Inadequate 20—average period of disability when seen 3.2 months
- None 10—average period of disability when seen 4.1 months

Average time after accident when seen by Impartial Examiner—5.9 months.

42 males.

Average age 40 years.

Editorial

TIME SAVING AND DISABILITY PREVENTION FOLLOWING INDUSTRIAL ACCIDENTS

Orthopedic surgeons more than ever before should be taking a definite place in the care of those injured in the industries. The experience of base hospitals and reconstruction hospitals during the war has amply shown that the Orthopedic Department has always something to bring to the Surgical Service. It has been shown that by the application of principles which have governed for years in the practice of Orthopedic Surgery there are not only prevention of deformity and lessening of disability but actually shortening of the length of time necessary for hospital care. It is now admitted that wounds heal more promptly when anatomical readjustment of damaged parts is made immediately following the injury tho often replacement has been made more with the purpose in mind of conserving ultimate function of the parts involved.

Recent articles like that of Trask in Modern Medicine (October, 1919) and that of Sever in this Journal (November, 1919) are sure to attract the attention of employers in industrial concerns where many accidents occur. Sever has abundantly emphasized the shorter period of disability and hospital care necessary for cases which he classifies as adequately treated. Trask speaks very plainly of the evil consequences which follow failure of early accurate diagnosis or when incompetent surgeons failed to provide the kind of care which the injuries require. Especially in fractures and in back injuries the principles which govern in orthopedic treatment have been shown to be essential, if early good results are to be obtained.

Orthopedic surgeons should in their various communities endeavor to demonstrate by local conditions the importance of prompt diagnosis and adequate care in these cases. While there has been a considerable widening of the influence of orthopedic surgery in the medical profession employers of labor are just beginning to hear of the possibilities of true reconstructive surgery. It is idle for orthopedic surgeons to remain modestly silent waiting for this impression to spread itself. The message should be carried to employers and workers, all of whom will be benefitted by a wider adoption of reconstruction surgical methods applied to the victims of these accidents.

Items of Interest to Orthopaedic Surgeons

Dr. George W. Hawley announces that he has opened an office for the practice of orthopedic and fracture surgery at Eleven East Forty-eighth Street, New York City.

Dr. John Dunlop, formerly of Washington, D. C., wishes to announce that he has established his office at 820 Baker-Detwiler Building, Los Angeles. Practice limited to Orthopedic Surgery.

Dr. C. B. Francisco has returned from overseas. He has opened an office at 416 Argyle Building, Kansas City, Missouri, where he will resume his practice in Orthopaedic Surgery.

Dr. Frederick C. Kidner, recently orthopaedic consultant of Base Section 3, A. E. F., has resumed the practice of Orthopedic Surgery. Office at 1337 David Whitney Building, Detroit, Michigan.

Dr. Robert B. Osgood has resumed his practice of Orthopedic Surgery at 372 Marlborough, Boston, after more than two years absence on military duty.

Dr. E. D. McClean announces his discharge from service overseas and return to private practice at Des Moines, Iowa, which will be limited to Orthopedic Surgery and Consultations.

Dr. Carroll L. Storey announces his separation from military service and the opening of offices for the practice of Orthopedic Surgery at the Empire Building, Detroit, Michigan. Dr. Storey was assigned for duty with the British by the Red Cross before the entry of America into the war. He returned to the United States in 1917 and was commissioned in the United States army.

Dr. Phil Hoffman and Dr. F. H. Albrecht have formed a partnership for the practice of Orthopaedic Surgery. 3657 Delmar Boulevard, St. Louis.

Col. W. E. Cooper, who was commanding officer at the Savenay Hospital Center, is now in charge at Fort Bliss, Texas.

General Sir Robert Jones was entertained by the orthopedic surgeons of Chicago following the meeting of the College of Surgeons in New York City.

MEETING OF THE PHILADELPHIA ORTHOPAEDIC CLUB

A meeting of the Philadelphia Orthopaedic Club was held on Thursday evening, November 20th, 1919, at the Philadelphia Orthopaedic Hospital and Infirmary for Nervous Diseases.

Dr. William J. Taylor presided.

Cases were shown by Drs. Gill, Crosson, Mutschler, Leavitt, Burr, Ashhurst and Owen.

Twenty-one members of the Club were present, and there was a general discussion of all cases by the members.

DeFOREST P. WILLARD,
Secretary.

THE SAMUEL D. GROSS PRIZE

FIFTEEN HUNDRED DOLLARS

Essays will be received in competition for the prize until January 1, 1920.

The conditions annexed by the testator are that the prize "shall be awarded every five years to the writer of the best original essay, not exceeding one hundred and fifty printed pages, octavo, in length, illustrative of some subject in Surgical Pathology or Surgical Practice, founded upon original investigations. the candidates for the prize to be American citizens."

It is expressly stipulated that the competitor who receives the prize shall publish his essay in book form, and that he shall deposit one copy of the work in the Samuel D. Gross Library of the Philadelphia Academy of Surgery, and that on the title page it shall be stated that to the essay was awarded the Samuel D. Gross Prize of the Philadelphia Academy of Surgery.

The essays, which must be written by a single author in the English language, should be sent to the "Trustees of the Samuel D. Gross Prize of the Philadelphia Academy of Surgery, care of the College of Physicians, 19 S. 22d St., Philadelphia," on or before January 1, 1920.

Each essay must be typewritten, distinguished by a motto, and accompanied by a sealed envelope bearing the same motto, containing the name and address of the writer. No envelope will be opened except that which accompanies the successful essay.

The Committee will return the unsuccessful essay if reclaimed by their respective writers, or their agents, within one year.

The Committee reserves the right to make no award if the essays submitted are not considered worthy of the prize.

WILLIAM J. TAYLOR, M. D.,
JOHN H. JOPSON, M. D.,
EDWARD B. HODGE, M. D.,
Trustees.

Orthopaedic Titles in Current Literature

AMPUTATION CASES, A Suggestion in Regard to;—Lowman, C. L.; *Military Surgeon*, 1919, Vol. 44, p. 617. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 365.

AMPUTATION STUMPS, Lengthening of,—Gallie, W. E.; *Lancet*, London, August, 16, 1919. Abst., *New York Medical Journal*, October 4, 1919, Vol. 60, No. 14, p. 596.

AMPUTATION STUMPS, In Relation to the Fitting of Artificial Limbs,—Rose, E. J.; *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, pp. 1590-1592. Discussion, pp. 1592-1594.

AMPUTATIONS, Cinematic, Utilization of the Muscles of a Stump to Actuate Artificial Limbs,—Putti, V.; *Medical Record*, 1919, Vol. 95, p. 1004. Abst., *Surg., Gynec and Obst.*, November, 1919, Vol. 29, No. 5, p. 365.

AMPUTATIONS, Consideration of Some Problems Presented by,—Starr, C. L.; *Journal. A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, pp. 1585-1590.

AMPUTATIONS, Standardization of,—Orr, T. G.; *Military Surgeon*, Washington, D. C., November, 1919, Vol. 45, No. 5, pp. 583-584.

ANATOMY and Kinesiology, Applied,—Bowen, W. P.; Lea & Febiger, Philadelphia, 1919, $3.50.

ARTHRITIS, Purulent, Treatment of,—Willems, C.; *Surg., Gynec and Obstetrics*, November, 1919, Vol. 29, No. 5, p. 362.

ARTHRITIS OF THE SPINE, Pain in,—Stoney, Florence; *British Medical Journal*, October 25, 1919, No. 3069, p. 550.

BONE COMPLICATIONS in Typhoid, Sierra, J. A.; *Medicina Ibera*, Madrid, August 30, 1919, Vol. 8, No. 95, p. 174.

BONE, Fertile Element in Repair of,—DeGaulejac and Nathan; *Revue de Chirurgie*, Paris, March-April, 1919, Vol. 38, No. 3-4, p. 264. Abst., *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, p. 1645.

BONE GRAFTS—Foote, E. M.; *U. S. Nav. M. Bulletin*, 1919, Vol. 13, p. 433. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 361.

BONE AND JOINT LESIONS, Principles for Treatment of;—Fasano, M.; *Gazzetta degli Ospedali e delle Cliniche*, Milan, August 14, 1919, Vol. 40, No. 65, p. 731.

BONE, Stapes, Cavity in the Structure of the,—Arias, Collar; *Medicina Ibera*, Madrid, September 20, 1919, Vol. 8, No. 98, p. 213.

BONE SURGERY, Operative, Leading up to Modern,—Chaffee, G.; *American Journal Surgery*, 1919, vol. 33, p. 63. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 360.

CEREBROSPINAL MENINGITIS at Camp Jackson, S. C.,—Baeslack, F. W.; *Michigan State Medical Society Journal*, Grand Rapids, November, 1919, Vol. 18, No. 2, p. 561.

CHONDRODYSPLASIA, Multiple Exostoses, Familial Deforming,—Gorsline, O. S.; *American Journal Roentgen*, 1919, Vol. 6, p. 271. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 357.

CONTRACTURE, Reflex, and Functional Impotence,—Barbe, A.; *Progress Medical*, Paris, September 6, 1919, Vol. 34, No. 36, p. 352. Abst., *Journal A. M. A.*, Chicago, November, 1919, Vol. 73, No. 20, p. 1560.

CRIPPLED CHILDREN, Cure of.—Jones, Sir Robert and Girdlestone, G. R.; *British Medical Journal*, October 11, 1919, No. 3067, p. 457. Correspondence, *British Medical Journal*, October 18, 1919, No. 3068, p. 508, Wheeler.

DEFORMITIES, Preventable, of the Upper Extremity,—Dozier, H. C.; *International Journal of Surgery*, New York, October, 1919, Vol. 32, No. 10, p. 289. Obst., *New York Medical Journal*, Vol. 60. No. 15, p. 629.

ELBOW, Flail;—Massart, R.; *Lyon Chirurgical*, March-April, 1919, Vol. 16, No. 2, p. 207.

ELBOW, Subcapsular Periosteal Resection of the; for Suppurative Arthritis After War Wounds,—Leriche, R.; *Presse Medicale*, Paris, 1919, Vol. 27, p. 517. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 363.

EXTREMITIES, Special Splints for Certain Injuries and Disabilities of the,—Cleary, E. W.; *Journal A. M. A.*, Chicago, November 15, 1919, Vol. 73, No. 20, p. 1495.

EXTREMITY, Upper, Preventable Deformities of,—Dozier, H. C.; *International Journal of Surgery*, New York, October, 1919, Vol. 32, No. 10, p. 289. Abst., *New York Medical Journal*, Vol. 60, No. 15, p. 629.

FEET, Osteoplastic Resection of Both,—Camera, Ugo; *Cirurgia degli Organi de Movimento*, Bologna, September, 1919, Vol. 3, No. 4, p. 401. Abst., *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, p. 1647.

FEMUR FRACTURE, Compound, Stiff Knee in,—Grange and Friel, *British Medical Journal*, October 4, 1919, No. 3066, p. 450.

FEMUR, Fracture of,—Bulkely and Sinclair; *Annals of Surgery*, 1919, Vol. 69, p. 496. Abst., *Surg., Gynec., Obst.*, November, 1919, Vol. 29, No. 5, p. 359.

FEMUR FRACTURES,—Campbell, W. C.,; *Annals of Surgery*, Philadelphia, November, 1919, Vol. 70, No. 5, pp. 600-602.

FEMUR FRACTURES: Application of War Lessons to Civil Practice,—Metcalf, C. R.; *Annals of Surgery*, Philadelphia, November, 1919, Vol. 70, No. 5, pp. 603-622.

FEMUR, Gunshot Fracture of,—Buchbinder, J. R.; *Surg., Gynec. and Obst.*, 1919, Vol. 29, p. 70. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 359.

FEMUR, Resection of the Head of the, in Certain Gunshot Wounds of the Hip Region,—Pratt, R. B., and Park, J. F.; *Military Surgeon*, 1919, Vol. 14, p. 16. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 363.

FEMUR, United Fractures of the Neck of the,—Treatment by Bone Transplantation,—Hessert, W.; *Surg., Clin.*, Chicago, 1919, Vol. 3, p. 399. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 360.

FINGERS, Webbed,—Beck, C.; *Surg. Clin.*, Chicago, 1919, Vol. 3, p. 723. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 357.

FOREARM, Fractures of the Lower End of the;—Troell, A.; *Svenska Lakaresallskapets Handlingar*, Stockholm, September, 30, 1919, Vol. 45, No. 3, p. 339. Abst., *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, p. 1650.

FRACTURE, Colles', Treatment of,—Bessesen, A. N.; *American Journal Surgery*, 1919, Vol. 33, p. 147. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 363.

FRACTURE OF SECOND CERVICAL VERTEBRA without Injury to Spinal Cord,—Dumont, F. L.; *Correspondenz-Blatt fur Schweizer Aerzte*, Basel, October 9, 1919, Vol. 49, No. 41, p. 1551.

FRACTURE, Compound, Femur, Stiff Knee in,—Grange and Friel; *British Medical Journal*, October 4, 1919, No. 3066, p. 450.

FRACTURE of the Femur,—Bulkely, K., and Sinclair, D. B.; *Annals of Surgery*, 1919, Vol. 69, p. 496. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 359.

FRACTURE OF THE FEMUR: The Application of War Lessons to Civil Practice—Metcalf, C. R.; *Annals of Surgery*, Philadelphia, November, 1919, Vol. 70, No. 5, pp. 603-622.

FRACTURE of Lower End of Humerus,—Wood, A. J.; *Medical Journal*, Australia, Sydney, September 13, 1919, Vol. 2, No. 11, p. 258.

FRACTURE, Gunshot, of the Femur,—Buchbinder, J. R.; *Surg., Gynec. and Obst.*, 1919, Vol. 29, p. 70. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 359.

FRACTURE, HUMERUS, Lower End of,—Wood, A. J.; *Medical Journal*, Australia, Sydney, September 27, 1919, Vol. 2, No. 13, p. 258.

FRACTURE OF THE PATELLA, Treatment of,—Smith, F. F. S.; *Indian Medical Gazette*, Calcutta, September, 1919, Vol. 54, No. 9, p. 336.

FRACTURE OF THE PELVIS, Report of Four Cases,—Newell, E. T.; *Tennessee State Medical Association Journal, Nashville*, October, 1919, Vol. 12, No. 8, p. 202.

FRACTURE OF TIBIA,—Olivier, R.; *Revue de Chirurgie*, Paris, March-April, 1919, Vol. 38, No. 3-4, p. 273.

FRACTURES,—Harsha, W. M., *Surg. Clin*, Chicago, 1919, Vol. 3, p. 589. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 358.

FRACTURES of Cervical Vertebra,—Strickler, F. P.; *Journal A. M. A.*, Chicago, November 1, 1919, Vol. 73, No. 18, p. 1390.

FRACTURES of the Lower End of the Forearm,—Troell, A.; *Svenska Lakaresallskapets Handlingar*, Stockholm, September 30, 1919, Vol. 45, No. 3, p. 339. Abst., *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, p. 1650.

FRACTURES, Neck of Femur,—Campbell, W. C.; *Annals of Surgery*, Philadelphia, November, 1919, Vol. 70, No. 5, p. 600-602.

FRACTURES, Pott's, Reconstruction and After-Care of Old Unreduced (and discussion),—Sneed, W. L., *Journal A. M. A.*, Chicago, November 1, 1919, Vol. 73, No. 18, pp. 1342-1344.

FRACTURES, Shell, of the Spine,—Plaggemeyer, H. W.; *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, pp. 1599-1604.

FRACTURES, Treatment of, Open and Closed: New Methods and New Apparatus Used,—Wilcox, A. E.; *Minnesota Medicine*, St. Paul, November, 1919, Vol. 2, No. 11, p. 413.

FRACTURES UNUNITED, of the Neck of the Femur,—Treatment by Bone Transplantation,—Hessert, W.; *Surg. Clin.*, Chicago, 1919, Vol. 3, p. 399. Abst., *Sur., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 360.

HAND, Injuries to and Their Treatment,—Sparks, J. C.; *Kentucky Medical Journal*, Bowling Green, October, 1919, Vol. 17, No. 10, p. 404.

HEEL, Plastic Repair of,—Lounsbury, B. F.; *Surg. Clin.*, Chicago, 1919, Vol. 3, p. 553. Abst., *Surg., Gynec and Obst.*, November, 1919, Vol. 29, No. 5, p. 365.

HIP, Snapping,—Mayer, Leo; *Surg., Gynec. and Obst.*, Chicago, November, 1919. Vol. 29, No. 5, pp. 425-28.

HUMERUS, Fracture of Lower End of,—Wood, A. J.; *Medical Journal*, Australia, Sydney, September 13, 1919, Vol. 2, No. 11, p. 258.

JOINTS, Syphilis in,—Lacapera and Laurent; *Paris Medical*, September 20, 1919, Vol. 9, No. 38, p. 221. Abst., *Journal A. M. A.*, Chicago, November 15, 1919, Vol. 73, No. 20, p. 1559.

JOINTS, War Wounds of,—Delrez, L.; *Archives Medicales Belges*, Diege, May, 1919, Vol. 72, No. 5, p. 513. Abst., *Journal A. M. A.*, Chicago, November 15, 1919, Vol. 73, No. 20, p. 1557.

JOINTS, Wounds of Large,—Francini, M.; *Chirurgie degli Organi Movimento*, Bologna, September, 1919, Vol. 3, No. 4, p. 341.

KNEE, Stiff, in Compound Fracture of Femur,—Grange and Friel; *British Medical Journal*, October 4, 1919, No. 3066, p. 450.

KNEE JOINT, Experimental Resection of the, of a Dog,—Ely, L. W.; *Annals of Surgery*, Philadelphia, November, 1919, Vol. 70, No. 5, pp. 586-599.

KNEE-JOINT INFECTIONS, Surgical Treatment of,—Orr, H. W., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, pp. 492-496.

KNEE-JOINT INJURIES, Penetrating,—Mitchell, H. C.; *Illinois Medical Journal, Oak Park*, Vol. 36, No. 5, p. 255.

KNEE-JOINT, Internal Derangements of the,—Painter, C. F.; *Journal Orthopaedic Surgery*, 1919, Vol. 1, p. 416. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 358.

KNEE-JOINT, Proliferation of the Fatty Tissue of the, Due to Trauma,—Dubs, J.; *Correzpondenz-Blatt fur Schweiz. Aerzte*, 1919, Vol. 49, p. 289. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 357.

MALUNION in a Fractured Tibia, Due to Tendon of Tibialis Anticus,—Harries, D. J.; *Indian Medical Gazette*, Calcutta, September, 1919, Vol. 54, No. 9, p. 340.

NERVE INJURIES, Peripheral,—Ney, K. W.; *Journal A. M. A.*, Chicago, November 8, 1919, Vol. 73, No. 19, p. 1427.

NERVE SUTURE AND NERVE GRAFTING, Technic of,—Elsberg, C. A.; *Journal A. M. A.*, Chicago, November 8, 1919, Vol. 73, No. 19, p. 1422.

NERVE SUTURE, Experimental Investigation of Certain Materials Used for,—Sargent, P., and Greenfield, J. G.; *British Medical Journal*, September 27, 1919, p. 407.

ORTHOPEDIC APPARATUS, Improvised, Exercising,—Reich, R. S.; *Journal A. M. A.*, Chicago, November 1, 1919, Vol. 73, No. 18, p. 1356.

ORTHOPEDIC SURGEON AND INDUSTRIAL ACCIDENTS, The,—Mayer, Leo; *Journal A. M. A.*, Chicago, November 15, 1919, Vol. 73, No. 20, pp. 1518-1522.

ORTHOPEDIC SURGERY, A Review,—Tubby, A. H.; *Practitioner*, London, October, 1919, Vol. 103, No. 4, p. 241.

OSTEOMYELITIS, Chronic Traumatic, Treatment of,—White, J. R.; Paul B. Hoeber, New York, Price $3.00.

OSTEOMYELITIS, Complicating Influenza,—Witherspoon, J.; *Tennessee State Medical Journal*, Nashville, October, 1919, Vol. 12, No. 8, p. 217.

OSTEOPLASTIC Resection of Both Feet,—Camera, Ugo; *Chirurgia degli Organi de Movimento*, Bologna, September, 1919, Vol. 3, No. 4, p. 401. Abst., *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, p. 1647.

PELVIS, Fracture of,—Newell, E. T.; *Tennessee State Medical Association Journal*, Nashville, October, 1919, Vol. 12, No. 8, p. 202.

POTT'S DISEASE, and Albee's Spinal Graft, A Note on,—Girdlestone, G. R.; *Journal Orthopaedic Surgery*, 1919, Vol. 1, p. 401. Abst., *Surg., Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 366.

POTT'S DISEASE, Operative Treatment of,—Arquellada, A. M.; *Pediat. Espan.*, 1919, Vol. 8, p. 165. Abst., *Surg., Gynec and Obst.*, November, 1919, Vol. 29, No. 5, p. 367.

RIBS, Ankylosis After Trauma,—Berard and Dunet; *Lyon Chirurgical*, March-April, 1919, Vol. 16, No. 2, p. 147.

RIBS, Cervical,—Castellanos, I.; *Vida Nueva*, Havana, August, 1919, Vol. 11, No. 8, p. 199. Abst., *Journal A. M. A.*, Chicago, November 15, 1919, vol. 73, No. 20, p. 1560.

RIBS, Cervical, Neurology of,—Church, A.; *Journal A. M. A.*, Chicago, 1919, Vol. 73, p. 1. Abst., *Surg., Gynec. and Obst.*, Chicago, November, 1919, Vol. 29, No. 5, p. 349.

SHOULDER, Dislocation of,—*Medical Science*, October, 1919, Vol. 1, No. 1, p. 8. Abstract.

SHOULDER, Loose, Treatment of,—Dionis-Du-Sejour; *Revue de Chirurgie*, Paris, March April, 1919, Vol. 38, No. 3-4, p. 229. Abst., *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, p. 1645.

SPINA BIFIDA Review,—*Medical Science*, October, 1919, Vol. 1, No. 1, p. 3.

SPINAL CORD, Fracture of Second Cervical Vertebra without Injury to,—Dumont, F. L.; *Correspondenz-Blatt fur Schweizer Arzte*, Basel, October 9, 1919, Vol. 49, No. 41, p. 1551.

SPINAL CORD LESIONS, Location of,—Thomas, Andre; *Paris Medical*, October, 4, 1919, Vol. 9, No. 40, p. 272. Abst., *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, p. 1645.

SPINE, ARTHRITIS of, Pain in,—Stoney, Florence; Letter, *British Medical Journal*, October 25, 1919, No. 3069, p. 550.

SPINE, Shell Fractures of,—Plaggemeyer, H. W.; *Journal A. M. A.*, Chicago, November 22, 1919, Vol. 73, No. 21, pp. 1599-1604.

SPLINTS, Special, for Certain Injuries and Disabilities of the,—Cleary, E. W.; *Journal A. M. A.*, Chicago, November 15, 1919, Vol. 73, No. 20, p. 1495.

SPLINTS, TRANSPORT, of the A. E. F.,—Osgood, R. B.; *Military Surgeon*. Washington, D. C., November, 1919, Vol. 45, No. 5, pp. 588-607.

TENDON TRANSPOSITIONS Surgery of, with Special Reference to the Importance of the Tendon Sheath,—Bernstein, M. A.; *Surg., Gynec. and Obst.*, 1919, Vol. 29, p. 55. Abst., *Surg. Gynec. and Obst.*, November, 1919, Vol. 29, No. 5, p. 362.

TIBIA, Fracture of,—Olivier, R.; *Revue de Chirurgie, Paris,* March-April, 1919, Vol. 38, No. 3-4, p. 273.

TIBIA, Fractured, Malunion in,—Harries, D. J.; *Indian Medical Gazette,* Calcutta, September, 1919, Vol. 54, No. 9, p. 340.

TYPHOID Bone Complications in,—Sierra, J. A.; *Medicina Ibera,* Madrid, August 30, 1919, Vol. 8, No. 95, p. 174.

VERTEBRA, Fracture of Second Cervical,—Cumont, F. L.; *Corres.-Blatt fur Schweiz. Aerzte,* Basel, October 9, 1919, Vol. 49, No. 41, p. 1551.

VERTEBRA, LUMBAR, Dislocation of, at Birth,—Holman, E.; *Journal A. M. A.,* Chicago, November 1, 1919, Vol. 73, No. 18, p. 1351.

Current Orthopaedic Literature

Late Results of Thumb Plasty. Emil Shepelmann. *Leitschf Ortho. Chir.*, 1919.

It is of interest to know the late results of a plasty of the thumb done by the author in 1913, four and one half years prior to the present publication. The author has followed up the result of the operation from time to time. By careful re-examinations the original operation was one of auto plasty of the thumb with skin taken from the thorax and the bony center furnished by bone inlay. The operation was carried out in two sittings.

A report on this artificial thumb made about a year after operation reads as follows: The artificial thumb is still without sensation. Between the bone of the artificial thumb and the metacarpus carrying it there is firm bony union. The bone of the artificial thumb carries two sinuses which lead to raw bone.

Further report almost two years after the plasty mentioned shows that the bone of the thumb still carries a small sinus covered by a scab. In regard to sensation there is a zone at the base one centimeter in width within which there is distinct sensation to touch. Other conditions as noted before.

At the end of two years the fistula had closed definitely, but the skin is still livid and bluish. The return of skin sensation has progressed.

Three years after, the sensation had not returned with exception of a small ring which now, however, has a width equal to one and one-half centimeters. The livid discoloration of the skin still persists but the skin appears to be more tough. The skin does not show any tendency to ulceration.

The final result four and one-half years after operation can be summed up as follows: X-ray shows firm fusion of the transplanted bone with the first metacarpal. Examination of sensory function shows that more than half of the artificial thumb is sensitive to touch. The color of the skin is slightly darker than the rest of the hand. There are no ulcerations.

This series of observations show that the functional improvement of the neoplastic thumb progressed slowly but restitution of sensation was not complete four and one-half years after the operation. The author thinks the use of the thumb may be expected to improve and, therefore, disability may be expected to decrease even after a period of years.—*Arthur Steindler, M. D., Iowa City, Ia.*

Central Dislocation of the Femur (Intra Pelvic Displacement). *Revue D'Orthopedic*, December, 1918.

Under the name of central dislocation there are described cases of penetration of the femoral head into the interior of the pelvis. This lesion is characterized by isolated fracture of the acetabulum and subsequent penetration of the femoral head. Henschen in 1909 collected forty-four cases of inter-pelvic fracture with displacement demonstrated by the X-ray and an additional 64 cases in which the fracture of the pelvis was evident but in which signs of

penetration of the head into the pelvis were absent. To these cases the author adds two of his own observation.

In regard to fracture deformity itself two types may be distinguished:

1. Fracture limited to the floor of the acetabulum.

2. Fracture of the acetabulum with fissures radiating into other parts of the pelvis.

In regard to the injuries to the soft structures, it is remarkable that in spite of the severity of bone injury the round ligament of the femoral head is mostly found intact. Of muscle injuries, there are more often ruptures of the ileo psoas and obturator muscles which are often the cause of intra-pelvic hemmorrage. Contusion of the obturator nerve is not infrequent and is a common cause of the accompanying neuralgia. Of all lesions of the blood vessels those of the obturator and gluteal arteries are mentioned; likewise injuries to the iliac veins.

The most frequent cause of isolated fracture of the cotyloid cavity of the pelvis is fall upon trochanter region from considerable height. In other cases the injury is caused by direct force applied to this region. In exceptional cases the fall upon the feet will transmit the force to the pelvis and cause inter-pelvic fracture.

In the majority of cases the cause is some traumatism which produces fracture of the pelvis forcing the femoral head through the floor of the acetabulum. In a small minority of cases, however, the penetrating of the head into the pelvis is gradually followed by fracture of the pelvis and favored by walking immediately after the injury. Finally there are a certain number of cases in which the wandering of the head into the pelvis does not take place until after considerable time has elapsed after the Injury.

One of the cases the author reports illustrates the type of progressive migration of the femoral head into the pelvis following the original injury. The clinical symptoms of central dislocation of the femur present a very characteristic picture. The injured present, aside from the shock of the injury, the picture of absolute functional disahility of the extremity involved. That is with a few exceptions in which attempts at walking are undertaken following the injury. The functional disability is almost always complete and upon examination of the patient a flattening of the trochanter region is noticed together with external rotation of the lower limb and rising of the greater trochanter upon Nelation's line. The distance between the greater trochanter and sym physis is diminished. The rectal or vaginal examination often reveals considerable tenderness in the region of the acetabulum. Regarding passive motion, flexion, extension and adduction, are usually present. Abduction and rotation, however, are almost always inhibited. Active motions are absolutely abolished on account of pain. The X-Ray picture does not fail to present characteristic features of the entrance of the head into the pelvis.

Treatment: Immediate treatment consists in reduction of the head of the femur under anesthesia. This reduction should be undertaken as soon as the shock has disappeared. In regard to the maneuvers leading to reduction, simple traction is prefered by some surgeons. Other operators prefer to combine longitudinal traction with lateral traction of the neck of the femur. Others begin their reduction maneuvers by flexion of the thigh upon the pelvis with

an assistant bringing about lateral traction in the direction of the axis of the neck of the femur. The limb is then brought down in extension in a position midway between abduction and adduction.

Open operation has been carried out by Vaughan from an incision identical with one for resection of the hip. The operation is very delicate and difficult. Healing did not take place in his case until after long and continued suppuration and then proper reduction was not obtained. It seems, therefore, after all conservative treatment and bloodless methods will yield better results than open operation.—*Arthur Steindler, M. D., Iowa City, Ia.*

A Contribution to the Study of "Stiff and Painful Shoulder." By Alfred J. Brown, M. D., F. A. C. S., Omaha, Nebraska. *Surg. Gynec. and Obstet.*, Vol. XXIX, October, 1919, No. 4.

It is the object of this paper to suggest that a tear of the tendons of the latissimus dorsi and teres major muscles may play an important role in the etiology of some of the cases of stiff and painful shoulder and also to point out certain therapeutic indications in the disability caused by this lesion.

Symptoms.

After a moderate trauma of rather definite type, usually a fall in which the patient puts out his arm to save himself, or a wrench of the shoulder caused by a sudden motion while the arm is abducted as while hanging on a strap in a street car, or a sudden muscular effort as pitching a baseball before the muscles are accustomed to the required motion, after such a trauma the patient feels a snap in the shoulder, followed by a severe sharp pain and in some cases the arm falls almost helpless by the side. Motion of the arm is extremely painful, especially the movements of abduction and that of external rotation when this is carried out with the arm in a position of moderate abduction. Because of the pain the arm is carried in the sling position and a moderate amount of atrophy of the deltoid muscle supervenes in a short time giving the appearance of nerve involvement.

There is a small range of motion amounting about to 10 degrees which is not painful. This is due to the fact that within this range the injured muscles are not placed on the stretch and consequently are not further traumatized, This symptom serves as a point of differentiation between extra-articular and intra-articular lesions of the shoulder for the latter, where joint surfaces are involved, pain occurs at the very beginning of joint movement.

Pathology.

There occurs as a result of the tear of the tendon a small haemorrhage at the site of injury and later an exudation of serum with the usual oedema a later phenomena of the process of repair. This extravasation in the tendon and beneath the periosteum places the latter on the stretch and makes it tender on pressure and on movement of the arm.

Treatment

In th acute stage the treatment consists of immobilization for a short time; active motion begun early for short periods and always within the limits of

pain; prevention of new insults to injured or reparative structures by splinting the deltoid and inhibiting motion tending to cause such insult (for any motion which does not cause pain may be freely used and will serve to keep up muscle tone); and local and general massage intelligently employed.

In the subacute stage treatment is essentially the same as in the acute except for mobilization. In this stage the patient is best encouraged to use the shoulder as much as possible but always within the limits of pain.

In the chronic and more severe cases it is necessary first to break up the firm scar and fibrous tissue which has formed in the tendons and the adhesions which have formed in the surrounding axillary tissues; also to overcome the shortening of the muscles which have taken place as the result of carrying the arm in the sling position for a considerable length of time. This is best accomplished, as recommended by Codman, by breaking up the adhesions under an anaesthetic.

SUMMARY.

1. Stiff and painful shoulder of a certain type falls into the general class of muscular strain about joints, and this muscular strain centers itself into the tendons of the teres major and latissimus dorsi muscles.

2. The condition manifests itself in (a) pain, produced by stretching the injured muscles; (b) distinct localized point of tenderness over the site of injury in the tendon and at its attachment to the bone; and (c) early development of a moderate amount of atrophy of the deltoid muscle due to the involvement of the circumflex nerve in the inflammatory and reparative processes.

3. The condition is amenable to treatment along lines which have proved successful in similar conditions in other parts of the body. This treatment is conservative and directed toward (a) prevention of trauma, (b) hastening of resolution of oedema and exudative processes, and (c) the formation of a pliable point of union by means of well vascularized connective tissue.— *Leo C. Donnelly, Detroit.*

THE USE OF ORTHOPAEDIC AND PROSTHETIC APPLIANCES IN THE LATE TREATMENT OF WAR DISABILITIES. By A. L. B. LeMesurier, M. D., Orthopaedist, Department S. C. R. *Medical Quarterly.*

The more common disabilities that lend themselves to treatment by appliances may be divided into four classes:

1. Nerve Injuries.
2. Disabilities of the joints.
3. Disabilities of the feet.
4. Amputations.

There are other conditions in which the use of appliances forms part of the late treatment, such as ununited fractures and prolonged suppuration of the joints.

1. NERVE INJURIES.

Most nerve lesions seen are the result of gunshot wounds, but occasional cases are due to contusion of the nerve or to prolonged pressure.

In these nerve cases appliances are used, not for treatment of the nerve lesion itself, but for the treatment of the muscles paralysed, with one of three

objects: (1) to prevent even momentary over-stretching of the paralysed muscles in cases where return of function may be expected, as where the nerve has not been divided or before or after its suture; (2) to prevent or correct deformity caused by contraction of the unparalysed opposing muscles; and (3) to hold the limb in the best position for function.

Whatever the object, the appliance in practically all cases should be worn continuously.

The nerves most commonly injured are the musculospiral, the ulnar and the sciatic, either in its main trunk, or in one of its two divisions.

There is a variable amount of weakness of supination, and practically always a paralysis of the extensor muscles resulting in wrist drop. The wrist should be kept always hyper-extended. To maintain hyper-extension several appliances have been advised, practically all being modifications of the original Jones "cock-up" splint.

Lesions of the ulnar nerve result in inability to separate the fingers and inability to flex the metacarpo-phalangeal and extended the interphalangeal joints. If neglected, the paralysis results in the typical "claw-hand" deformity. To prevent or correct this deformity, the splint used flexes the metacarpo-phalangeal and extends the interphalangeal joints.

Lesions of the sciatic nerve above its divisions may be complete. The resulting paralysis depends upon the site of the lesion, and may involve all the muscles of the leg and foot or the dorsi-flexors, with or without the peroneals, or the plantar-flexors alone. Except in the last-mentioned case, foot drop always occurs, and tends to increase. The treatment, as far as appliances are concerned, consists in maintaining the foot at a right angle with the leg; the position most useful in standing and walking.

2. Disabilities of the Joints.

The disabilities of the joints that lend themselves to treatment by appliances, fall into two main classes. The first class comprises those cases of lack of stability, following ligamentous or bony injury, or excision of the joint. The commoner joints thus affected are the elbow and the knee. In the elbow, lack of stability is usually due to excision, following an infected gunshot fracture involving the joint, an operation that was performed fairly frequently during the war.

Lack of stability at the knee-joint may be caused by injury to some of the ligaments, particularly the crucial ligaments or may be the result of excision of the joint with failure to obtain bony ankylosis. Absolute rigidity of the limb is essential for weight-bearing, and is best obtained by the use of a Thomas caliper splint, with the lower ends of the side bars bent in at a right-angle, and fitting loosely into a tunnel in the heel of the boot, to allow movement of the ankle-joint. The body weight may be diverted from the limb by having the splint long enough to prevent the sole of the foot from quite touching the sole of the boot; the weight being thus transmitted from the boot, through the side bars and ring of the splint, to the ischial tuberosity. This splint gives greater stability to the knee-joint than any other appliance, but it has the disadvantages that it is difficult for the wearer to put on and take off unaided, and that the knee is held at all times rigidly extended. In the minor degrees of instability

a knee-brace is sufficient, with the joint opposite the knee fitted with a stop to prevent extension beyond 180 degrees. Another class of case that may be included here, although not properly a disability of the joint, is that in which, with the joint itself normal, there is a hyper-extension or recurvation of the limb as a result of a fracture of the lower end of the femur, or the upper end of the tibia united with a posterior angulation.

The second main class of joint disabilities in which appliances are useful, is the class in which there is stiffness of the joint, short of bony ankylosis, and in which it is desired to increase movement. This stiffness may be caused by fixation of the muscles above in a large scar—a condition most frequently seen following wounds of the upper arm and thigh complicated by a fracture—or by adhesions in a contraction of the capsular and other ligaments following inflammation or prolonged fixation.

3. Disabilities of the Feet.

Most cases of foot disability due to service, are cases of weak foot or flat foot. Varying degrees of this disability are met with. The least severe and the commonest, are the cases of strain of the muscles, ligaments and fasciae, particularly on the inner side of the foot, due to prolonged marching with a heavy pack, often beyond the point of muscular fatigue. As a rule the foot is quite flexible. The forepart can be actively adducted and the longitudinal arch made prominent; but when weight is borne the arch becomes flattened and the fore-foot abducted. There is pain, particularly after long standing or walking, referred chiefly to the region of the astragalo-navicular joint and up the front of the leg. In practice it is best to advise a patient with such a foot to avoid any occupation that necessitates prolonged standing, and to give him a lift of three-eighths of an inch on the inner side of heel and sole of boot. If there is any tendency for the foot to capsize inward, the heel may be flanged, that is, made wider at the bottom than the top on the inner side. An ordinary well made, leather soled boot, preferably straight on the inside, with plenty of room for the ball and toes, is suitable for this purpose. If the arch of the boot tends to break and flatten, it may be supported by carrying the heel forward about ¾ inch on the inner side.

In cases where the foot is very flexible and the flattening of the arch on weight bearing is extreme, the Whitman plate may be used with advantage.

When the flat foot is accompanied by much pain, muscular spasm and rigidity, it should be forcibly wrenched under an anaesthetic, into a position of inversion, and kept fixed in plaster for about three weeks. At the end of that period, the patient may be allowed up for an increasing time daily, always in a boot with the inner side of the sole and heel raised.

This rigidity due to muscular spasm should not be confused with the rigidity seen in flat feet of long duration. These later are often comparatively painless. A boot raised on the inner side is usually sufficient.

When the valgus deformity is marked, particularly when caused by a badly united fracture about the ankle, an ankle brace may be worn. This consists of a single upright bar, passing up the outer side of the leg, between the heel of the boot and a band around the calf. There should be a free joint either between the end of the brace and the heel of the boot, or at the level of the

ankle joint. A strap, somewhat T-shaped, is sewn by its base to the inner side of the boot. The two arms of the T encircle the ankle, and are buckled on the outside of the metal upright, thus correcting the valgus deformity by pulling the ankle towards the brace.

A second large class of cases requiring treatment by modified boots is that in which there is pain on pressure of the sole over the heads of one or more of the metatarsal bones. This occurs in a variety of conditions, some of the most frequent being metatarsalgia, hammer-toe, claw-foot, hallux valgus, etc. Great relief may be obtained by the use of the metatarsal bar, 3/16-inch or ¼-inch thick and ¾-inch wide obliquely across the bottom of the sole parallel to and well behind the line of the heads of the metatarsal bones.

4. Amputations.

When a stump first heals, there is always a certain amount of oedema present. As this subsides, and as the muscles, particularly those that have no joint to act through, waste, a shrinking of the stump occurs. The shrinking is at first rapid but gradually becomes slower and after a year or more stops entirely. It is best to wait until the first and most rapid part of the shrinking has taken place before supplying a finished artificial limb. With the lower extremity, as soon as the stump can stand it, a peg-leg should be worn; this being for most stumps the best possible treatment. For the thigh, the standard peg, consists of a padded ring like that of the Thomas splint, which grips the stump immediately below the ischial tuberosity on which all the weight is borne. Two metal side bars run down and unite about the knee level to carry the wooden peg, which is armed with a rubber tip. A leather corset encircles the thigh and is laced in front, to tighten as the stump shrinks. The corset should extend to just below the stump and should have a leather hammock slung near the bottom to exert any desired pressure on the end of the stump.

When the stump has shrunk so that there is no obvious oedema, and the muscles have largely lost their flabbiness and become firm—two to four months after healing of the wound—a finished leg may be supplied. As the stump continues to shrink and the bucket becomes loose, additional stump socks may be put on until four or five are worn. The bucket should then be lined with leather, and, as shrinking continues, additional socks again added up to the number of four or five.

Many amputation cases for a renewal of an artificial limb when the fault lies in a surgical condition of the stump. The conditions most apt to cause trouble are a nerve adherent to the scar, a tender nerve-bud, a spur growing from near the end of the bone, or a sequestrum buried in the stump. It is usually a waste of time to fit such cases with new limbs. The condition should be given time to subside, or should be treated surgically, before the attempt is made.

The material used for the bucket is important. It has been well established by practice that the bucket made of some rigid material, so fashioned as to take pressure on selected points and to avoid others, is preferable to the bucket made of material that is yielding, and takes pressure from all points evenly.

The simplest type of artificial leg is that used for amputations at, or a little below, the middle of the thigh. The points most likely to cause trouble

from pressure are the perineum, the tendon of the adductor longus which becomes prominent as the stump is swung forward, the great trochanter and, more rarely, the femoral vein.

For disarticulations thru the hip-joint, a device called the "tilting table" is employed. This is a basin-shaped piece of willow, made to conform to the hip region and to take pressure chiefly from the ischial tuberosity. It is fastened by a broad leather band to the pelvis, and follows it in all its movements.

The artificial arm makes a very poor substitute for the natural limb. The reason for this is the variety and complexity of the movements normally performed by the arm and hand. As a rule an artificial arm can be supplied, provided the stump is a fair length, fitted with a special appliance which will permit the wearer to do one single action moderately well; but no appliance yet produced can begin to copy the variety of movements of the normal hand. The nearest approach to the general usefulness of the natural hand, is obtained by means of one or the other of the various hooks.

The tendency in artificial arms is all towards simplicity and lightness. For work, in both above—and below—elbow amputations, the "working arm" is used. This consists in its simplest form of a leather bucket for the stump, kept in position by suitable harness, with a hook attached directly to its end.

Much ingenuity has been shown in devising special terminal appliances for artificial arms, usually with the object of assisting the wearer to perform some special act. These appliances are often useful, but only to those men whose work consists in the frequent repetition of the single action.—*Leo C. Donnelly, Detroit.*

Fractures of the Lower Third of the Femur. Joseph Van de Velde, M. D. *Annals of Surgery*, October, 1919.

To overcome the usual deformity of backward displacement of the lower fragment the author uses in certain cases the following methods:

1. Wiring the fragments, in cases with little or no comminution.

2. Traction on the femoral condyles by the use of ice tongs, Steinman pins, or Willems screws, when there is considerable comminution.

3. Depages method of vertical suspension of the lower fragment, combined with horizontal traction on the leg is used in all the other types where the first two methods are not used. Where there is cancellous bone the use of the Willems screws has not been satisfactory.—*Custis Lee Hall, Washington, D. C.*

Gunshot Fractures of the Humerous Treated by Suspension and Traction. Morris K. Smith, M. D. *Annals of Surgery*, October, 1919.

An excellent article well illustrated, giving the author's experience with gunshot fractures of the humerus at American Red Cross Hospital No. 2, under Colonel Joseph A. Blake, M. C. The use of traction and suspension without a fixed splint is used, and the fragments are controlled by the amount of traction and countertraction that is used. The humerus is placed in abduction, and the elbow flexed at ninety degrees. The advantages claimed for the method are, first, maintenance of favorable position from the point of view of drainage;

second, ease and simplicity of dressings; third, comfort of the patient; fourth, control and maintenance of reduction; and fifth, earlier restoration of function. About 152 cases were treated in the series.—*Custis Lee Hall, Washington, D. C.*

Pain in the Lumbosacral Region Associated With Congenital Malformation of the Transverse Processes of the Fifth Lumbar Vertebra. By Andre J. Richards, M. D., Roentgenologist to the New York Orthopaedic Hospital, New York City. *The American Journal of Roentgenology*, Vol. VI, September, 1919, No. 9.

Examination of about 60 patients complaining of pain in the lumbosacral region has shown that 10% did not present abnormalities. Of those 60% were slight or pronounced malformations of the transverse process of the fifth lumbar vertebra. We classify them in four different groups, each case presenting one or several characteristics of a particular group:

First Group—One or both transverse processes are longer and larger than normal; they may apparently be in contact with the sacrum and iliac bones. Their shape sometimes suggests a change directly traceable to this contact; or the formation of a bursa at the point of contact is indicated.

Second Group—One or both fifth lumbar transverse processes are very markedly long or large and seem to have taken an oblique upwards direction from contact with the sacrum and iliac bones; the space between the lower border of the process and the upper border of the sacrum appears very narrow and sometimes it has entirely disappeared.

The two preceding groups are not so much true malformations of the transverse processes as malposition of the bones of the pelvis; the sacrum is apparently situated very low between the iliac bones. This is more frequent in males than females.

Third Group—This group is represented by the very marked enlargement outwards and downwards of the 5th lumbar transverse processes which present a size two or three times that of the process of the opposite side, its shadow overlapping the shadow of the upper part of the iliac bone and sacrum, with sometimes the presence of a bursa, but no actual joint formation.

Fourth Group—This group would include the malformation of one or both fifth lumbar processes which are considerably larger than normal and united with the upper part of the sacrum by a true joint.

In all cases the vertebra bearing the malformed process or processes is a true fifth lumbar, the sacrum showing the regular number of segments and the transverse process of the vertebra above presenting the characteristic aspect of the fourth lumbar.

We may consider the pain as being produced either:

1. By compression of soft tissues, muscular or fibrous between the bony parts.

2. By irritation and arthritis of normal or abnormally formed bursae and joints.

3. By the slow acting strain on ligaments when a very slight relaxation of

the joints of this region is produced, these joints normally allowing extremely limited movements.

4. By pressure or tension due to the persistant malposition of the bones on different segements of the trunks of the nerves which emerge from the lateral foramen of the fifth lumbar vertebra, especially of the lumbosacral cord.

Until the ossification is nearly completed, real contact between a large fifth transverse prccess and the sacrum or illium is not produced or the tissues which come in contact are not hard, and yield easily to pressure. The abnormal joint or bursa is not formed. With the completion of ossification, if the pressure of the enlarged prccess is made on the sacrum, there may be a tendency to lateral tilting of the fifth lumbar and, in the upright position, a tendency to compensatory opposite tilting of the sacrum, which causes strain on both sacro-iliac joints and subsequent arthritis, this arthritis being generally more marked on the side opposite to the malformation. Arthritis also is generally more marked on the side cppcsite the malformation. When the malformation is unilateral the patient generally complains of pain over the region of both sacro iliac joints, the pain often being more severe on pressure of the joint oppcsite the malformation. The pain radiated to the hip, buttock, ischiatic region, also to the thigh and leg, is generally felt on the same side as the malformation.

The roentgenological conclusions about the position of the bones of the lumbosacral region can rarely be arrived without making several plates taken from different angles, above and below the level of the upper border of the sacrum. The stereoscope does not seem to help a great deal in this investigation. The lateral view is not of great value as far as the examinatien of the fifth lumbar processes is concerned, but is of first importance, when obtainable, to appreciate the extent of spondylolisthesis or the degree of the backward tilting of the sacrum.—*Leo C. Donnelly, Detroit.*

The Barrel-Stave Splint in Fracture of the Clavicle. By Hubert A. Royster, M. D., Raleigh, N. C. *Annals of Surgery*, Vol. LXX, October, 1919, No. 4.

To apply the barrel-stave splint to a fractured clavicle, the center of the stave is found, and this should be placed over the center of the patient's manubrium, at the suprasternal notch. The stave is then sawed off at each end to fit just inside the head of each humerus while the shoulders are drawn backwards. One inch from each end a nail is driven into, but not through, the splint. The splint is then padded with cotton, retained by a bandage, and placed in a posi tion as first measured, the concave surface being next to the chest. While the splint is held in place and the shoulders kept firmly back, bandages are tied to the nails, carried under each axilla and crossed on the back In the figure-of-eight fashion; as many turns are made and the stave is drawn as tightly as necessary. If there is a tendency of the splint to turn or to slip, adhesive plaster may be applied to reinforce the bandage. If the patient is a heavy, muscular subject, the arm is put into a sling.

The appealing quality of this dressing is its comfort. The patient may use his hands and forearms at will without disturbing the fragments, and he is

relieved of the distress which the older dressings give. We have been told that the deformity in fracture of the clavicle is produced by "the action of the powerful muscles attached to the scapula." It is due, not so much to the pull of the muscles, as it is to the dropping downward and inward of the shoulder by its own weight.—*Leo C. Donnelly. Detroit.*

Radiographic Differential Diagnosis of Bone Affections in Infancy and Childhood. Julius H. Hess. *Medical Clinic North America*, 1919, III, 31.

Osteogenesis imperfecta tarda.—The radiograph shows: Multiple fractures, mostly intraperiosteal; excessive callus; thin shadows cast by all bones due to the lack of density of osseous tissue; no curving or bending of the long bones; cortex thin or apparently absent in some places, irregular thickness with no thickening on concave side of shaft; medullary canal enlarged and shows mottled shadows.

Rachitis.—The radiograph is not absolutely necessary to diagnosis but is valuable in following the effect of treatment. The plate usually shows: Thin shadow, due to diminished calcium content; fractures are usually present but are complete and there is very little formation of callus; bowing is characteristic especially in the lower limbs; the cortex is about the same as in osteogenesis imperfecta except that there is definite thickening on the concave side, almost pathognomonic; epiphyses show broad flaring and cupping of the epiphyseal end of the diaphysis, irregular enlargement of the entire epiphysis but decrease in density.

Scorbutus.—An irregular circumscribed shadow of variable density at the end of the diaphysis, due to hemorrhage, is a characteristic finding in this disease. If congenital syphilis is excluded, this shadow may be considered as pathognomonic. Subperiosteal shadows from deposit of osteophytes at the seat of the hemorrhage are also seen but are less constant than the epiphyseal shadow. Fractures are less common.

Tuberculosis.—The plate shows bone atrophy in very early stages of the disease. Within the active zone the spongiosa appears to be washed out, and if the focus is near the periphery the bone appears as if absorbed. Callus is very deficient. The periosteum in the neighborhood of the lesion appears as if sparated from the cortex, due to subperiosteal new bone granulation tissue. The surface of the underlying compact bone is smooth; if it should be rough and irregular, one should think of periosteal sarcoma rather than tuberculosis. This is quoted from Frazer.

Osteomyelitis does not give a conclusive diagnostic picture in the X-ray before the end of the second week. After that time a periosteal proliferation and new periosteal bone formation shows up near the diseased area. A positive diagnosis can be made when a sequestrum can be outlined. A very extensive ossifying periostitis is also present by the time the sequestrum appears.

In chronic osteomyelitis the plate shows patches of varying density due to rarefaction and collection of debris and pus. Dense shadows will be seen from

layers of dead cortical bone. These have a definite periphery beyond which are the lighter shadows of the living bone.

Sarcoma gives a shadow ot absorption with no periosteal reaction or new bone formation. If medullary there may be shadows resembling spicules, or islands of bone with little or no normal bone remaining in the immediate neighborhood.

In syphilis the picture varies with the age of the infant. In the first weeks of life the pathognomonic osteochondritis syphilitica produces "either a homogenous transverse shadow or a streak interrupted by transverse streaks at the epiphyseal line." Later deep shadows along the outer surface of the cortex are produced by the ossifying periostitis which is present at that stage. The older the infant the less marked the shadows of osteochondritis and the more marked those of periostitis. The findings in syphilis may resemble those of osteomyelitis but the lesions of the former are usually multiple. In the healing stages of syphilis there may be cupping of the epiphyses as in rachitis, but this will be irregular in different joints and not uniform as in rachitis.—*William Arthur Clark.*

Rapidly Fatal Spinal. M. A. Caries, M. D., Dublin, M. R. C. P., London. *British Medical Journal*, Saturday, August 30, 1919.

Three cases were reported somewhat similar. Case 1, Aged 26, reported sick call April 28, 1917, on account of pain in back but carried on until April 30, when he became weak in legs. Admitted to hospital May 1, unable to stand due to paresis, later same day complete facial paralysis, both legs, knee and ankle jerk absent plantar feeble. Anaesthesia over greater part of legs.

Motor and sensory reflexes of both arms normal, pupils normal and reacted to light and accommodation. Lumbar puncture gave nothing distinctly abnormal. The day following anaesthesia had extended to umbilicus. Temperature 105, Lumbar puncture fluid straw colored from blood leucocytes, later polymorphonuclear leucocytes and a few micrococci were found.

The patient became delirious, unconcious and died May 5.

Post Mortem.— Body of powerful, well developed man, no emaciation. Spinal canal a considerable amount of thick yellowish pus was found extradurally extending up as far as fourth dorsal and down to tenth dorsal process most active at ninth dorsal. The upper and lower surfaces were most involved, however the sides of the vertebrae were involved, the right more than the left.

Lungs bound down by adhesions. Numerous military tubercles were found in upper and lower lobes, both lungs involving pleura. There was no consolidation, cavitation or caseation, or other evidence of old tuberculosis.

No pus from spinal canal gram and stapylococci were seen. This was the most rapid of the three cases, the other two terminating fatally at 9 and 15 days responsively. In all, the onset was swift and without warning.

The writer suggests the cases of this type might chance to have no small medico-legal signaificance in civil life.—*James R. Elliott, Kansas City, Mo.*

PHASES OF WAR SURGERY: BONE TRANSPLANT: FROM THE TIBIA TO THE LOWER JAW FOR LOSS OF SUBSTANCE. By Chas. A. Powers, M. D., Lieut. Col., M. R. C., U. S. Army, Denver, Colo. *Annals of Surgery*, Vol. LXX, October, 1919, No. 4.

CASE 1, INJURED AUGUST, 1915—There was pseudarthrosis of the right side of the body of the lower jaw, with apparently considerable loss of substance. Heavy, dense scar tissue on the right side of face in the region. Widest possible preliminary removal of this cicatrix.

July 16, 1917. Bone transplant. (On the preceding day dental splints had been applied, and "open-bite" supports applied in the usual way.) The entire region of lost bone was a dense mass of hard cicatricial tissue, despite the preliminary attempt at excision of the scar. This cicatricial tissue was removed as much as possible, great care being taken to avoid opening the oral cavity. Posterior fragment exposed, it being much drawn in by the ptergoid muscles. Very careful dissection of the soft parts from the bone especially at the end of the fragment where it was solidly fibrous and densely adherent. Anterior fragment exposed and cleared. Loss of substance was found to be over two inches. Seat made in posterior fragment by Albee saw and chisel, care being taken to go down into bleeding bone. Seat made in anterior fragment, but this is difficult because of dense eburnation of bone. Cultures proving negative taken from each cut in bone. Dry wound secured. Fragment of suitable length taken from tibia by twin saw, the periosteum being so raised laterally as to drop over sides of fragment. Ends of graft beveled so that the periosteum dropped over these obliquely cut ends. Transplant applied to lower jaw, held in place by forceps, and the soft tissue carefully sewn over it by interrupted sutures of fine black silk. The sutured soft parts held the fragment in place, but the fragment did not "wedge" into the two portions of the lower jaw proper. Covering of transplant difficult in this case because of the density of cicatricial tissue. Subcuticular stitch to skin without drainage. Very large, firm, carefully applied dressing, with heavy crinoline support. Leg put up in plaster-of-Paris for six weeks. Each subsequent dressing done with the detail of an aseptic operation. Smooth course. Inter-dental supports and splints removed at the end of three months and solid union found throughout. Patient re-examined from time to time for one year from date of operation. The union held. Function of jaw practically perfect.

Results—Eleven transplants made on ten patients, one case being double. In these eleven operations there were three infections, each infected case being followed by loss of the graft. Results in the eleven cases: 7 cases, or 63 plus per cent. of complete successes; 3 or 27 plus per cent. of complete failures; and 1 case, 9 per cent. undetermined, but a probable success when last seen in June, 1918. The conditions of success embraced absolutely solid consolidation, excellent dental approximation, good mastication of not too hard food, and a good speaking voice.—*Leo C. Donnelly, Detroit.*

RD
701
J6
n.s.
v.1
cop.2
Biological
& Medical
Serials

The Journal of bone and joint surgery

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY